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Jin Qi

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Andrew Winton, Adviser

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Dedication

This dissertation is dedicated to my parents Qi Zhenhui and Kong Suyan, and my sister Qi Zhan for their unconditional love and support.

Abstract

In the first essay, I examine how the threat of activist intervention affects firm innovation. I argue that when firm managers pursue innovation, firm stock price may reflect less precise information about the firm's fundamental value, which makes firm managers vulnerable to shareholder intervention. Under the threat of shareholder intervention, managers will be biased against innovation projects to minimize their job termination risk. Consistent with this mechanism, I find that: (1) increasing the threat of shareholder intervention has a significant and economically important negative impact on firm innovation; (2) the threat of shareholder intervention exerts less negative effects on firms that are more likely to have efficient stock prices (e.g., firms with more monitoring institutional investors and/or more financial analysts). To establish causality, I use a novel identification strategy that relies on a quasi-natural experiment of activist fund closures to generate exogenous variation in the level of shareholder intervention threat. The difference-in-differences estimates show that firm-level innovation significantly improves following exogenous activist fund closures. The results from this identification strategy suggest a negative causal effect of shareholder intervention threat on firm innovation.

In the second essay, I examine the effects of shareholder derivative litigation on board effectiveness. Specifically, I investigate the effects of Delaware's judicially-led reforms in 2003. In response to the Sarbanes-Oxley Act, Delaware courts adjusted their corporate law jurisprudence, moving to a more restrictive application of the business judgment rule and more vigorous enforcement of officer and director fiduciary duties. By lowering the procedural hurdles to derivative litigation (e.g., demand requirement, and special litigation committee), the courts allowed more shareholder derivative lawsuits to survive pretrial motions to dismiss. These reforms have greatly enhanced the ability of shareholders to effectively pursue derivative litigation against corporate directors and officers. Using a sample of 2153 publicly-traded firms from 1999 to 2007 and the difference-in-differences method, I find that following the 2003 reforms, Delaware chartered corporations have exhibited higher CEO pay-for-performance sensitivity and greater CEO turnover-performance sensitivity than have non-Delaware firms. These results show that empowering shareholders to pursue derivative litigation provides high-powered incentives to directors to improve their corporate governance decisions.

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Chapter 1

Introduction

Beginning with Berle and Means (1932), agency problems that arise from the separation of ownership and control have become a prominent research area. It has been argued that managers act in their own self-interest, and they may make decisions that conflict with the best interests of the shareholders. Economists have attempted to identify the corporate governance systems that can constrain managers' opportunistic behaviors. Recent research shows that large institutional investors can play a critical role in corporate governance. Institutional investors, such as mutual funds, pension funds, and hedge funds, have sizable ownership in public-traded firms, which provides them incentives to bear the cost of monitoring managers. In addition, these institutional investors are highly skilled and well-resourced professional shareholders who may have the power to effect changes in corporate governance practice.

Prior literature shows that institutional investors can exert governance through three main mechanisms. The first is shareholder intervention (also known as "voice"), which includes conducting proxy contests, voting against management proposals, or suggesting a strategic change via a public shareholder proposal (e.g., Shleifer and Vishny, 1986; Kaplan and Minton, 1994; Kang and Shivdasani, 1995; Agrawal and Mandelker, 1990; Brickley, Lease and Smith, 1988). The second mechanism for shareholders to exert governance is disciplinary trading (also known as “exit” and “Wall Street Walk”), where shareholders sell a company’s shares, pushing down the stock price (e.g., Parrino, Sias and Starks, 2003; Admati and Pfleiderer, 2009; Edmans, 2009). Prior research examines the incentives and choices of institutional investors to use intervention vs. trading, and the interaction effects of these mechanisms (e.g., Kahn and Winton, 1998; Maug, 1998; Edmans and Manso, 2011).

Although most of the research on shareholder governance focused on intervention and disciplinary trading, a recent literature has started to examine a new governance mechanism: shareholder litigation. Shareholders can sue directors and managers for breach of fiduciary duties. There is increasing evidence that the threat of shareholder lawsuits changes director and manager behavior (e.g., Ferris *et al.*, 2007; Becker and Strömberg, 2012; Appel, 2015).

My dissertation examines the roles of institutional investors in corporate governance, with a focus on the mechanisms of shareholder direct intervention and shareholder litigation. In Chapter 2, I investigate how the threat of shareholder intervention affects firm incentives to pursue innovation. Over the past two decades, shareholder activism has become a mainstream activity that can be initiated with a modest investment stake. Activist investors, such as Carl Icahn, Nelson Peltz, and Bill Ackman have achieved notable success in obtaining board seats, pressuring companies to return extra cash through dividends or share buybacks, or forcing the exploration of a sale of the company. My research examines activist institutional investors, and evaluates their impact on firm technological innovation. My main finding is that the threat of activist intervention discourages publicly-traded firms from pursuing innovation. I argue that in publicly-traded firms, shareholder intervention often is contingent on the information reflected in stock prices. When firm managers pursue innovation, stock prices may incorporate less accurate information about the value of the innovation projects. When the stock price is undervalued, firm managers are vulnerable to activist intervention. So, when activist investors are present, firm managers may prefer conventional projects and forgo valuable innovation projects. I empirically evaluate the impact of the threat of activist intervention on firm innovation outcomes.

Chapter 3 is focused on the mechanism of shareholder litigation. I investigate whether litigation rights have an impact on director incentives and behavior. I argue that shareholder litigation can severely damage director reputation and career opportunities. Although directors' and officers' liability insurance (D&O insurance) can protect directors against legal liability, directors still concern themselves with the reputation outcome of lawsuits. Thus, the threat of shareholder litigation can motivate directors to take effort to effectively monitor firm management. I examine a legal event that has dramatically changed the firm litigation environment. In 2003, Delaware judiciary reformed its state corporate law, increasing scrutiny of director liability for breach of fiduciary duty. The reforms have enhanced the ability of shareholders to pursue derivative litigation. My study shows that the threat of shareholder litigation improves board effectiveness when making decisions on CEO compensation and replacement. This study provides evidence that derivative litigation has economically important effects on director incentives and corporate governance practice.

An important challenge in the empirical research on corporate governance is the presence of endogeneity issues, such as unobservable heterogeneity and simultaneity. The endogeneity problem may lead to biased and inconsistent parameter estimates. In Chapter 2, when examining the effects of activist investors on firm innovation, the threat of activist intervention might be endogenous. It is possible that less innovative firms may attract more activist institutional investors and, thus, face a higher level of intervention threat. In Chapter 3, when I examine the effects of shareholder litigation on board of director incentives, the threat of shareholder litigation is endogenous, because poorly-performing boards are more likely to be sued by shareholders. To address the endogeneity problem, I use quasi-natural experiments to generate exogenous changes in the threat of activist intervention and in the threat of shareholder litigation.

In Chapter 2, I employ a natural experiment of activist investor fund closures. During the 2007-2009 financial crisis, a large portion of activist institutional investors closed their businesses. The main reason for these fund closures is that market-wide liquidity shocks caused dramatic declines in activist hedge fund performance. A main strategy of activist hedge funds is to force the target firms into a takeover. During the financial crisis, this strategy became unprofitable and difficult to implement as the global merger and acquisition market plummeted. The closure of activist funds is an exogenous event, because the closure decisions are unlikely to be driven by the information on firm innovation performance. I hypothesize that these closure events cause a decline in the threat of activist intervention facing the publicly-traded firms. I utilize the difference-in-differences method, and test how firm innovation changed following the exogenous activist fund closures. I find that firm innovation significantly increases following the exogenous decrease in the threat of activist intervention. Using the activist fund closures as a natural experiment, I address the reverse causality concerns, and provide evidence for the causal effect of the threat of activist intervention on firm innovation.

In Chapter 3, I use Delaware's judicially-led reforms in 2003 as a quasi-natural experiment. This event generated state-level change in the threat of shareholder litigation. The main reason for Delaware's reform is the threat of federal preemption. Delaware has a prominent role in American corporate law, as more than 50% of publicly-traded companies in the United States are incorporated in the State of Delaware. Before the Enron scandal, Delaware built a reputation as the most management-friendly state. After the passage of the Sarbanes-Oxley Act, Delaware courts were mindful of the preemptive threat of federal legislation, and the possibility that uniform federal standards could erode Delaware's advantage in incorporation business. In response, Delaware courts took the initiative to reform the state corporate law. They imposed stricter judicial standards for evaluating director and officer fiduciary duties. They lowered the procedural hurdles that blocked derivative litigation (e.g., the demand requirement, and special litigation committee). They liberalized Section 220 of the Delaware General Corporation Law, which permits shareholders to inspect corporate books and records to build "particularized facts" for pleading demand futility. Together, these reforms empowered shareholders to pursue derivative litigation. Importantly, Delaware's reforms occurred at the state level and, thus, are exogenous to individual firm's governance practice. Using this quasi-natural experiment, I can make causal inference about whether shareholder litigation rights have an impact on corporate governance.

In sum, this dissertation examines the roles of institutional investors in exercising corporate governance. I examine the "direct intervention" mechanism, and show that the threat of activist intervention has a negative impact on corporate innovation. I also investigate the "shareholder litigation" mechanism. I find that litigation rights can be an effective tool for institutional investors to exert governance. Empowering shareholders in their litigation rights has a positive impact on board of director effectiveness in performing their monitoring functions.

Future research may examine the joint effects of various governance mechanisms of institutional investors. Most prior research has studied the governance mechanisms independently. I am interested in examining how the various shareholder governance mechanisms (e.g., intervention, disciplinary trading, and litigation) interact with each other, and how the effectiveness of corporate governance is jointly determined by these governance mechanisms. Moreover, it would be fruitful to study different types of institutional investors (e.g. index funds, activist funds). Given they have their own private benefits, they may disagree in certain corporate governance policies. It would be interesting to know how various types of investors coordinate and resolve conflicts in the process of corporate governance. Another potential avenue for future research is to investigate how institutional investors and other major players, such as boards of directors, employees, and labor unions, interact in the decision process of governance. I believe that research in these areas will greatly improve our knowledge of corporate governance.

Chapter 2
The Threat of Shareholder Intervention and Firm Innovation

2.1. Introduction

In the past two decades, an important feature of corporate governance reform is the growing shift from a director-centric to a more shareholder-centric governance system. The rule changes of the Securities and Exchange Commission (SEC) have greatly empowered shareholders to exert influence or control over board elections, management compensation, and major business strategies. Firm management is now facing an increasing intervention threat from shareholders, especially activist shareholders. *The Economist* (February 7, 2015) estimates that, "since the end of 2009, 15% of the members of the S&P 500 index of America's biggest firms have faced an activist campaign...[and] about 50% of S&P 500 firms have had an activist on their share register." How does this important change in the corporate governance landscape affect corporate long-term investment, and in particular, firm innovation? My research examines this question by constructing a theoretical framework that explains managers' incentives under the threat of shareholder intervention and by empirically documenting the economic impact of intervention threat on firm innovation.

Burkart, Gromb, and Panunzi (1997) theorize that shareholder control constitutes an expropriation threat that *ex ante* reduces managerial incentives and non-contractible, firm-specific investment. Shareholder control that enables shareholders to reverse managers' investment decisions, reduces the private benefits that managers can obtain from exerting effort and initiating profitable projects. My research extends Burkart, Gromb, and Panunzi by examining a new mechanism that is based on contingent control of shareholders. In today's publicly-traded firms, the exercise of shareholder control is often contingent on the information reflected in stock prices. Relying on stock prices as a public signal of a firm's performance is rooted in the theory that stock prices aggregate information from various market participants and, thus, provide valuable guidance (Hayek, 1945; Grossman, 1976; Roll, 1984; Holmstrom and Tirole, 1993). If shareholder intervention is based on the information contained in stock prices, the information efficiency of stock prices is key to determining shareholder intervention and managerial incentives.

Prior literature shows that pursuing innovation increases information asymmetry between corporate insiders and outside investors, because firm managers are often reluctant to disclose innovation-related information to the market, and uniqueness of the innovation project makes it difficult for outside investors to precisely determine the value of the project (Bhattacharya and Ritter, 1983; Maksimovic and Pichler, 2001; Aboody and Lev, 2000). Recent research provides evidence that, for firms with greater information asymmetry, stock prices are less efficient in incorporating value-relevant information. For example, Kelly and Ljungqvist (2012) empirically demonstrate that stock prices fall substantially as a firm's information asymmetry increases. Thus, pursuing innovation is associated with less precise information reflected in stock prices. When shareholder intervention decisions are based on the information contained in stock prices, the reduction in price informativeness will increase the likelihood of shareholder intervention. Since firm managers are inclined to minimize job termination risk, managers under shareholder intervention threat will be biased against innovation projects. Therefore, I propose that the threat of shareholder intervention negatively affects firm manager innovation incentives.

To empirically evaluate the economic impact of shareholder intervention threat on firm innovation, I construct a sample of 2,097 U.S. publicly-traded firms from 2001 to 2008. The threat of shareholder intervention is measured by the percentage of firm outstanding shares held by activist institutional investors. This study examines how the threat of shareholder intervention *ex ante* affects managers' innovation incentives. Thus, the intervention threat measure is based on the presence of activist institutional investors who have a history of activist interventions against any U.S. incorporated firms, rather than based on SEC 13D filings, which indicates actual intervention at the focal firm. In addition, prior studies on shareholder activism have focused on the activist investors with 5% ownership. According to a recent report by J.P. Morgan, even small stakes (less than 1%) can be sufficient for activist shareholders to be effective.[1] My primary

[1] See the J.P. Morgan report "The Activist Revolution: Understanding and Navigating a New World of Heightened Investor Scrutiny" (January 2015). The report shows that about 26.8% of activist campaigns targeting $10 billion-plus market capitalization companies and 59.2% of campaigns targeting $25 billion-plus companies were

measure of shareholder intervention threat is based on the ownership of all activist institutional investors. I construct additional intervention threat measures with thresholds of 1% and 5% ownership to assess the effects of more influential activist investors. The results from OLS and negative binomial estimations show that the threat of shareholder intervention has a significant and economically important negative effect on firm innovation.

In the above-mentioned mechanism, the threat of shareholder intervention reduces managers' innovation incentives mainly because innovation is often associated with less precise information as reflected in stock prices. If this mechanism is valid, then for firms that are more likely to have efficient stock prices, such as those held by more monitoring institutional investors and/or followed by more financial analysts, shareholder intervention threat will exert less effects on firm innovation. Improved stock price efficiency means that the value of the innovation project is more likely to be reflected in stock prices. Thus, firm managers who undertake innovation projects are less likely to be mistakenly penalized. Consistent with the proposed mechanism, I find that for firms with higher holdings by monitoring institutional investors, the effect of shareholder intervention threat on innovation becomes weaker. Also, for firms that are followed by more financial analysts, the threat of intervention exerts a less negative effect on firm innovation.

A potential concern is that the negative association between shareholder inter-

initiated by activists who held less than 1% of firm outstanding shares at announcement.

vention threat and firm innovation is driven by activist investors' selection of less innovative firms. To address this reverse causality, I rely on a quasi-natural experiment of activist investor closures to generate exogenous variation in the threat of shareholder intervention. During the 2007-2009 financial crisis, market-wide liquidity shocks caused dramatic declines in the performances of activist hedge funds. Greenwood and Schor (2009) show that pressuring firms into a takeover is the most profitable activist strategy. However, the collapse of the global mergers and acquisitions (M&A) markets makes this major activist strategy unprofitable. With increasing redemption requests and declining returns from activist strategies, many activist investors decided to wind down their businesses and redeem their investors. I identify 20 activist investors who closed their operations in the U.S. during 2007-2010, accounting for 12.7% of the activist investors in 2006. Activist investor closures are plausibly exogenous, as the closure decisions are unlikely to have been motivated by information on the innovation performances of portfolio firms. Difference-in-Differences (DiD) estimation results provided here indicate that firm innovation significantly improves relative to control firms following exogenous activist investor closures. This finding provides clear evidence for the causal effect of shareholder intervention threat on firm innovation.

This research contributes to the literature on how corporate governance affects firm innovation. The existing literature shows that governing an innovative firm is fundamentally different from governing a conventional firm. The optimal corporate governance to motivate innovation should involve high tolerance for failure (Manso, 2011; Tian and Wang, 2014), a compensation scheme that rewards long-term success (Ederer and Manso, 2013), and protection of managers against career risks (Aghion, Van Reenen, and Zingales, 2013). My research shows that increasing shareholder power and intervention threat reduces manager incentives to innovate. More restrictions on shareholder intervention may be beneficial for governing innovative firms. In addition, recent studies by Edmans (2009), and Edmans and Manso (2011) theorize that institutional investors can exercise governance through trading, which causes stock price to be more efficient. My study suggests that this governance role of institutional investors is essential for innovative firms.

The remainder of this chapter is organized as follows. Section 2.2 is a review of the literature on corporate governance and innovation. Section 2.3 contains the theoretical framework and hypotheses. Section 2.4 describes the data and variable measurements. Section 2.5 contains the primary empirical results. In Section 2.6, I discuss the quasi-natural experiment of activist investor closures, and estimate the effects of activist investor closures on firm innovation. Section 2.7 concludes the chapter.

2.2. Related Literature

This research fits into the theoretical and empirical literature on corporate governance and innovation. An early paper by Holmstrom (1989) states that innovation projects may have extraordinary returns, but they are also highly risky, unpredictable, and idiosyncratic. The success of innovation projects requires long-term commitment and substantial human effort. Recent research has highlighted that governing innovative firms should be fundamentally different from governing conventional firms, due to these unique characteristics. For example, Manso (2011) theorizes that the optimal innovation-motivating incentive scheme should involve substantial tolerance for failure and rewards for long-run success. Tian and Wang (2014) show that initial public offering (IPO) firms backed by more failure-tolerant venture capital investors are more likely to pursue innovation. Aghion, Van Reenen, and Zingales (2013) demonstrate that institutional investors help increase firm innovation incentives by "insulating" firm managers against the reputational consequences of innovation failure, rather than "disciplining" lazy managers. Ederer and Manso (2013) use a controlled laboratory experiment to show that the standard pay-for-performance compensation, which has been effective in inducing managerial effort in conventional firms, is detrimental to innovative firms. In addition, they find that threats of job termination undermine innovation incentives, while "golden parachutes" mitigate these negative effects.

The traditional view regarding dual-class share structure is that excess insider voting rights entrench managers and decrease firm value (Gompers, Ishii, and Metrick, 2010). Chemmanur and Jiao (2012) contend that a dual-class share structure may benefit IPO firms because the entrenchment effect enables talented managers to undertake the innovation projects that are intrinsically more valuable, but have high near-term uncertainty. Similarly, in the prior literature anti-takeover provisions are viewed as destroying shareholder value by entrenching firm managers. However, Chemmanur and Tian (2013) provide evidence that anti-takeover provisions help improve corporate innovation by insulating firm managers from short-term pressures in the equity market. In addition, Sapra, Subramanian, and Subramanian (2014) suggest that there is a non-monotonic U-shaped relationship between external takeover pressure and firm innovation. In particular, firms are more innovative when anti-takeover laws are severe enough to deter takeovers or when an unhindered market is developed for corporate control.

This research is also related to the literature on the effects of financial markets and stock prices on corporate innovation. Stein (1989) develops a model of short-termism driven by the stock market. In his model, firm managers mislead the stock market by forsaking good investments to boost current earnings. In equilibrium, the stock market correctly adjusts for earnings inflation. He and Tian (2013) demonstrate that financial analysts of the market exert pressure on firm managers to meet short-term earnings targets, which impedes a firm's commitment to long-term innovation investment. Fang, Tian, and Tice (2014) provide evidence that stock liquidity impedes firm innovation by exposing firms to the risk of hostile takeovers and by reducing institutional investors' incentives to gather information.

2.3. Theoretical Framework

Burkart, Gromb, and Panunzi (1997) identify a trade-off between shareholder control and managerial initiative. Even when shareholder control is *ex post* efficient, it constitutes an expropriation threat that *ex ante* reduces managerial incentives and non-contractible, firm-specific investment. They propose a mechanism in which shareholder control reduces the private benefits that managers can obtain from exerting effort and initiating profitable projects. Their research suggests using a dispersed ownership structure to prevent outside investors from exercising excessive control. I extend Burkart, Gromb, and Panunzi by examining a new mechanism that emphasizes contingent control of shareholders.

Aghion and Bolton (1992) show that optimal control allocations may involve contingent control, in which controls are allocated between investors and managers (entrepreneurs) depending on the realization of the first-period signal. The prior literature shows that the stock market is a monitor of managerial performance (Holmstrom and Tirole, 1993), and many corporate governance actions are driven by the information summarized in stock prices. For example, Smith (1996) shows that shareholder activism is often triggered by poor stock price performance, and Coughlan and Schmidt (1985) demonstrate that the replacement of top management is associated with changes in stock price performance. Shareholders in today's publicly-traded firms often base their intervention decisions on the information reflected in the stock prices, especially when shareholders do not have incentives to obtain private information due to high monitoring costs. In this paper, I examine how managers make decisions on innovation investment, when the intervention of activist investors is contingent on the information reflected in the stock prices.

2.3.1 Innovation and Stock Price Efficiency

Firm projects are categorized into "innovation" projects and "industry standard" projects. Following March (1991) and Manso (2011), an innovation project refers to the exploration of new actions that are superior to previously known actions, and an industry standard project refers to the exploitation and refinement of existing well-established actions. The discrete choice between an innovation project and an industry standard project can be viewed as a choice on the firm's strategic direction. Schumpeter (1942) and Aghion and Howitt (1992) propose that innovation drives economic growth through creative destruction. A new innovation destroys the rents of established companies that enjoy monopoly power derived from their previous technological capability. These studies imply that in the long run, firms that pursue innovation as their strategic direction have higher cash flows than firms that focus on exploiting an existing technology advantage.

An established view in the innovation literature is that pursuing innovation increases information asymmetry between the corporate insiders and the outside investors. When a firm undertakes an innovation project, the manager of the firm may be reluctant to disclose the innovation project to prevent competitors from imitating it. For example, Bhattacharya and Ritter (1983) propose a model in which innovative firms face a trade-off when deciding whether to disclose private information about innovation projects. Disclosing innovation information to outside investors may help raise external financing at better financial terms. However, the downside risk is that competitors may obtain useful innovation information from the disclosure, which may reduce the firm's initial advantage in the innovation rivalry. In a related study, Maksimovic and Pichler (2001) show that the firms that are pioneering new technologies may finance their investment in such technologies with private offerings instead of public offerings, in order to prevent revealing the innovation information to potential industry entrants. These studies imply that firms disclose less information when undertaking an innovation project than when undertaking an industry standard project.

Informed market participants, such as institutional investors and financial analysts, can obtain private information through monitoring and analyzing firms. Innovation is a complicated process that requires substantial amounts of knowledge and monitoring effort to fully assess the potential of a project. An innovation project is unique to the firm that developed the innovation. The relative uniqueness of the innovation makes it difficult for outsiders to precisely determine the value of the project. Thus, informed market participants may have less precise information if a firm undertakes an innovation project than if the firm selects an industry standard project. Aboody and Lev (2000) provide evidence that R&D

is a major contributor to information asymmetry, and that insiders exploit this asymmetry to gain substantially from insider trading.

Recent research provides evidence that information asymmetry leads to inefficient stock prices. Kelly and Ljungqvist (2012) empirically demonstrate that increases in information asymmetry causes a substantial fall in stock prices. Based on rational expectations models, they show that greater information asymmetry exposes uninformed investors to more liquidity risk and, thus, reduces uninformed investors' demand for the assets. Fishman and Hagerty (1992) provide an alternative theory that the efficiency of stock prices is partly determined by the distribution of information between the insiders and the market professionals. They state that "unequal access (to information) leads to less aggressive trading by the market professionals and more aggressive trading by the insider, but the net effect is an order flow that is less sensitive to traders' information and thus less informative (p.112)." Overall, these studies show that greater information asymmetry is associated with less efficient stock prices.

In sum, when compared with "industry standard" projects, pursuing "innovation" projects is associated with less efficient stock prices. The association of innovation and stock price efficiency has important implications for firm managers when they are under significant threat of shareholder intervention.

2.3.2. A Model of the Threat of Shareholder Intervention and Firm Innovation

Consider a publicly-traded firm with significant amounts of shares held by institutional investors. The timeline of the firm is shown in Figure 1. At date 0, the firm's manager makes investment decision $i \in \{0, 1\}$. He can undertake either an "industry standard" project ($i = 0$) or an "innovation" project ($i = 1$). The manager knows with perfect certainty that the firm's future cash flows (realized at date 2) is a under industry standard project, and is $a+b$ under innovation project. It is assumed that $b > 0$. That is, the future cash flow of the innovation project is higher than that of the industry standard project. At date 1, activist shareholders assess firm performance and decide on whether to intervene. Conditional on the activist shareholders being unsatisfied with firm performance, the extent to which activist shareholders can implement intervention is denoted by $\lambda \in [0, 1]$. In most cases, activist shareholders have partial control. They do not have a majority of the votes, but they can unite with other shareholder groups to gain effective control and implement intervention. λ represents activist shareholders' ability to intervene, which we interpret as a measure of intervention threat. Although intervention occurs at date 1, firm managers at date 0 have some knowledge about λ. If intervention occurs at date 1, the project is liquidated, and the firm manager is replaced. It is assumed that the industry standard project and the innovation project have the same liquidation value V_L. If no intervention occurs, at date 2,

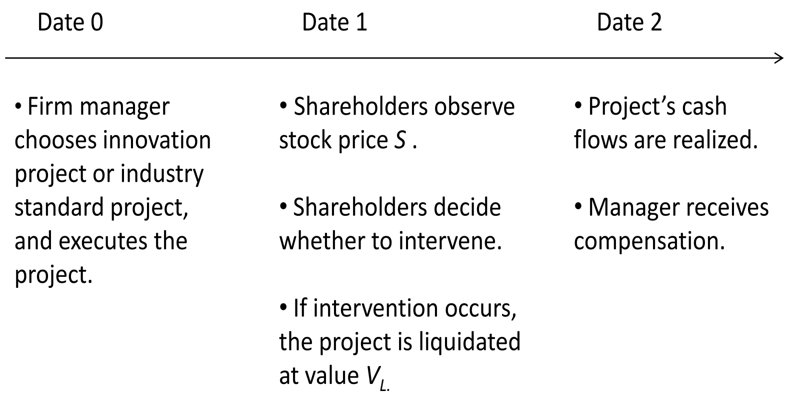

Figure 1: Timeline of the Model

the project's cash flow is realized. Both shareholders and managers are assumed to be risk-neutral. For simplicity, I assume a zero discount rate across time periods.

After the firm manager has undertaken a project, at date 1 shareholders observe a signal $S \in [0, \infty)$. If the signal is below shareholders' threshold level S^c, activist shareholders may initiate intervention. The literature on corporate governance shows that stock market is a monitor of managerial performance (Holmstrom and Tirole, 1993). Many corporate governance actions are driven by the information summarized in stock price. For example, Smith (1996) shows that shareholder activism is often triggered by poor stock price performance, and Coughlan and Schmidt (1985) show that the replacement of top management is associated with changes in stock price performance. Following this literature, stock price is taken as the major signal of firm performance.

Stock price efficiency is defined as the extent to which stock price reflects a firm's fundamental value. More efficient stock price implies that stock price measures firm value with less noise. After an investment project is set up at date 0, informed traders at date 1 trade the firm's stock based on their private information. If the firm invests in the innovation project, potential information asymmetry may cause outside market professionals to trade less aggressively, and thus less information of outside market professionals would be incorporated into stock price. Firm stock price at date 1 would be less precise with respect to the firm's fundamental value.

At date 0, before making project decisions, firm managers conjecture about the firm's stock price at date 1 for each of the alternative projects. If the industry standard project is undertaken, stock price would reflect firm value more precisely, and date 1 stock price would be distributed according to $S_0 \sim N(a, \sigma^2)$. If the innovation project is pursued, stock price may measure firm value less precisely, and date 1 stock price would be distributed as $S_1 \sim N(a+b, \eta^2)$. In this setting, $\eta^2 > \sigma^2$, implying that innovation project is associated with more noise in stock price. Denote $\tau^2 = \eta^2 - \sigma^2$.

Before making investment decisions, managers also conjecture about the shareholder's intervention threshold. The shareholder's objective is to maximize firm value, and shareholders rely on stock price to infer firm performance. Shareholders will choose intervention threshold S^c to maximize the firm's value:

$$\max_{S^c} V = \int_{S^c}^{\infty} S\, h(S)\, dS + \int_0^{S^c} V_L\, h(S)\, dS \tag{1}$$

The first term represents the firm's value when no intervention occurs. Shareholders receive stock price value S at date 2. The second term represents the firm's value when shareholders intervene and liquidate the project. $h(S)$ is the probability density function of stock price. The first-order condition for the shareholder's maximization problem is

$$\frac{\partial V}{\partial S^c} = -S^c h(S^c) + V_L h(S^c) = 0 \tag{2}$$

The first-order condition gives $S^c = V_L$. Firm managers conjecture that shareholders intervene when the firm's stock price is below the liquidation value.

The manager's objective is to maximize compensation. Manager's compensation is a function of the project's cash flow. If the project is continued to period 2, the manager's compensation is $k(a+b)$ (if undertaking the innovation project), and ka (if undertaking the industry standard project). If the project is intervened and liquidated, the manager's compensation is zero. At date 0, when the manager chooses an investment project, he considers both the project's expected future cash flow and the probability of intervention.

First, we look at the case where the manager undertakes an industry standard project.

$$\begin{aligned} U(i=0) &= ka \cdot \left\{ 1 - \int_0^{V_L} \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\frac{1}{2} \left(\frac{S_0 - a}{\sigma} \right)^2 \right] dS_0 \cdot \lambda \right\} \\ &\qquad + 0 \cdot \int_0^{V_L} \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\frac{1}{2} \left(\frac{S_0 - a}{\sigma} \right)^2 \right] dS_0 \cdot \lambda \end{aligned}$$

$$= ka \cdot \left[1 - \Phi\left(\frac{V_L - a}{\sigma}\right) \cdot \lambda\right] \tag{3}$$

The expression enclosed in braces is the probability that the industry standard project will continue to date 2, which is equivalent to one minus the probability of intervention. The probability of intervention $\int_0^{V_L} \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\frac{1}{2}\left(\frac{S_0 - a}{\sigma}\right)^2\right] dS_0 \cdot \lambda$ consists of two parts: (1) the probability that the signal observed by shareholders, S_0, is below the threshold level V_L, and (2) the intervention threat λ, which is the probability that active shareholders can implement intervention ($0 \leq \lambda \leq 1$). The former part can be obtained by integrating the probability density function of the normal distribution. It can also be written in the form of a cumulative distribution function, as shown by $\Phi\left(\frac{V_L - a}{\sigma}\right)$. Here, Φ represents the cumulative distribution function (CDF) of the standard normal distribution. σ is positive by assumption.

Similarly, when undertaking an innovation project, the manager's expected compensation is given by

$$\begin{aligned} U\,(i=1) &= k(a+b) \cdot \left\{1 - \int_0^{V_L} \frac{1}{\sqrt{2\pi}\sqrt{(\sigma^2+\tau^2)}} \exp\left[-\frac{1}{2}\left(\frac{S_1 - a - b}{\sqrt{(\sigma^2+\tau^2)}}\right)^2\right] dS_1 \cdot \lambda\right\} \\ &\qquad + 0 \cdot \int_0^{V_L} \frac{1}{\sqrt{2\pi}\sqrt{(\sigma^2+\tau^2)}} \exp\left[-\frac{1}{2}\left(\frac{S_1 - a - b}{\sqrt{(\sigma^2+\tau^2)}}\right)^2\right] dS_1 \cdot \lambda \\ &= k(a+b) \cdot \left[1 - \Phi\left(\frac{V_L - a - b}{(\sigma^2+\tau^2)^{1/2}}\right) \cdot \lambda\right] \end{aligned} \tag{4}$$

When compared with an industry standard project, an innovation project increases the manager's compensation by kb, and increases the noise of the signal by τ^2. It is assumed that $V_L < a$. This means that the shareholder intervention threshold is below the expected cash flow of the industry standard project. Since $a < a + b$, it follows that $V_L < a + b$. This condition guarantees that both the industry standard project and the innovation project are in the manager's choice set.

When a manager decides on which project to undertake, he compares the expected compensation under the innovation project with that under the alternative industry standard project.

$$\triangle U \equiv U(i=1) - U(i=0) = k(a+b) \cdot \left[1 - \Phi\left(\frac{V_L - a - b}{(\sigma^2 + \tau^2)^{1/2}}\right) \cdot \lambda\right] - ka \cdot \left[1 - \Phi\left(\frac{V_L - a}{\sigma}\right) \cdot \lambda\right] \tag{5}$$

In (5) $\triangle U > 0$ means that the expected compensation of undertaking the innovation project is higher than the expected compensation of industry standard project. Firm managers will prefer the innovation project. $\triangle U < 0$ implies the reverse. The sign of $\triangle U$ is basically determined by two factors: (1) b, the expected cash flow of the innovation project in excess of the industry standard project; (2) τ^2, the increased noise in the stock price signal of the innovation project.

Firm managers face a trade-off. If they undertake the innovation project, their compensation improves with higher expected future cash flow, but the increased noise in stock price signal may evoke higher probability of intervention. In (5), the term $\Phi\left(\frac{V_L - a - b}{(\sigma^2+\tau^2)^{1/2}}\right) \cdot \lambda$ shows the probability of intervention when the innovation project is undertaken. The probability of intervention is increasing in τ^2, and decreasing in b. Compare the two terms $\Phi\left(\frac{V_L - a - b}{(\sigma^2+\tau^2)^{1/2}}\right)$ and $\Phi\left(\frac{V_L - a}{\sigma}\right)$ in (5). If

$\frac{V_L - a - b}{(\sigma^2+\tau^2)^{1/2}} > \frac{V_L - a}{\sigma}$, that is $0 < b < \frac{(a-V_L)\left[(\sigma^2+\tau^2)^{1/2}-\sigma\right]}{\sigma}$, pursuing the innovation project increases the probability of intervention. If $\frac{V_L - a - b}{(\sigma^2+\tau^2)^{1/2}} < \frac{V_L - a}{\sigma}$, that is $b > \frac{(a-V_L)\left[(\sigma^2+\tau^2)^{1/2}-\sigma\right]}{\sigma}$, undertaking the innovation project decreases the probability of intervention. In the second case, the positive effect of b is large enough to counteract the negative effect of τ^2.

To determine the sign of $\triangle U$, we examine both the expected project cash flow and the probability of intervention. First, consider the case $b \geq \frac{(a-V_L)\left[(\sigma^2+\tau^2)^{1/2}-\sigma\right]}{\sigma}$. The innovation project has higher expected cash flow than the industry standard project $(a + b > a)$. The probability of intervention, if the firm pursues an innovation project, is lower than (or equal to) the probability of intervention when the firm undertakes an industry standard project. That is, $\Phi\left(\frac{V_L - a - b}{(\sigma^2+\tau^2)^{1/2}}\right) \leq \Phi\left(\frac{V_L - a}{\sigma}\right)$. It follows immediately that $\triangle U > 0$. This implies that when the benefit of the innovation project $b \geq \frac{(a-V_L)\left[(\sigma^2+\tau^2)^{1/2}-\sigma\right]}{\sigma}$, firm managers will prefer the innovation project.

Now consider the case $0 < b < \frac{(a-V_L)\left[(\sigma^2+\tau^2)^{1/2}-\sigma\right]}{\sigma}$. By pursuing an innovation project, the firm has higher expected cash flow $(a + b > a)$. But an innovation project also incurs higher probability of intervention, $\Phi\left(\frac{V_L - a - b}{(\sigma^2+\tau^2)^{1/2}}\right) > \Phi\left(\frac{V_L - a}{\sigma}\right)$. The sign of $\triangle U$ is determined by the relative magnitude of b and τ^2. If the effect of b dominates that of τ^2, $\triangle U$ is positive. Conversely, if the effect of τ^2 dominates that of b, $\triangle U$ becomes negative.

Proposition 1: *There exists a unique threshold* $\bar{b}$ *on the interval* $\left(0,\ \frac{(a-V_L)\left[(\sigma^2+\tau^2)^{1/2}-\sigma\right]}{\sigma}\right)$ *such that for all* $b > \bar{b}$, $\triangle U$ *is positive; and for all* $b < \bar{b}$, $\triangle U$ *is negative.*

Proof:

From (5)

$$\lim_{b\to 0} \triangle U = ka \cdot \left[1 - \Phi\left(\frac{V_L - a}{(\sigma^2+\tau^2)^{1/2}}\right)\cdot\lambda\right] - ka \cdot \left[1 - \Phi\left(\frac{V_L - a}{\sigma}\right)\cdot\lambda\right] < 0 \tag{6}$$

Recall that when $b = \frac{(a-V_L)\left[(\sigma^2+\tau^2)^{1/2}-\sigma\right]}{\sigma}$, $\triangle U > 0$. In addition, $\triangle U$ is assumed to be continuous in b on the interval $\left(0,\ \frac{(a-V_L)\left[(\sigma^2+\tau^2)^{1/2}-\sigma\right]}{\sigma}\right]$. By the Intermediate Value Theorem, there exists $\bar{b}$ on the interval $\left(0,\ \frac{(a-V_L)\left[(\sigma^2+\tau^2)^{1/2}-\sigma\right]}{\sigma}\right)$ such that $\triangle U = 0$. Furthermore,

$$\frac{\partial \triangle U}{\partial b} = k\left[1 - \Phi\left(\frac{V_L - a - b}{(\sigma^2+\tau^2)^{1/2}}\right)\cdot\lambda\right] + k\,(a+b)\,\Phi'\left(\frac{V_L - a - b}{(\sigma^2+\tau^2)^{1/2}}\right)\cdot\frac{\lambda}{(\sigma^2+\tau^2)^{1/2}} > 0 \tag{7}$$

This implies that $\triangle U$ is monotonically increasing in b. Hence, there is a unique $\bar{b}$ on the interval $\left(0,\ \frac{(a-V_L)\left[(\sigma^2+\tau^2)^{1/2}-\sigma\right]}{\sigma}\right)$, such that for all $b > \bar{b}$, $\triangle U > 0$; and for all $b < \bar{b}$, $\triangle U < 0$. Q.E.D.

The key implication of Proposition 1 is that shareholder intervention threat imposes a threshold $\bar{b}$, which determines whether an innovation project is worth pursuing. Without the shareholder intervention threat, all innovation projects that have $b > 0$ can be undertaken. When shareholder intervention threat is present, only the innovation projects that have $b > \bar{b}$ can be pursued. The threshold $\bar{b}$ blocks the innovation projects that have moderate levels of expected cash flow.[2]

[2] Looking back at the history of technology development, we may find that many innovations were not very profitable at the early stage. Some firms invested in the innovation and nurtured the new technology. As the new technology became mature and highly profitable, these firms arose as leaders in their industry. For example,

Proposition 2*: The threshold $\bar{b}$ increases with shareholder intervention threat λ.*

Proof:

Recall that when $b = \bar{b}$, $\triangle U = 0$. By substituting $\bar{b}$ for b into (5), we have

$$k(a+\bar{b}) \cdot \left[1 - \Phi\left(\frac{V_L - a - \bar{b}}{(\sigma^2+\tau^2)^{1/2}}\right) \cdot \lambda\right] - ka \cdot \left[1 - \Phi\left(\frac{V_L - a}{\sigma}\right) \cdot \lambda\right] = 0 \tag{8}$$

Totally differentiating (8) with respect to $\bar{b}$ and λ, and combining the expressions, we obtain

$$\frac{\partial \bar{b}}{\partial \lambda} = \frac{\left(a+\bar{b}\right)\Phi\left(\frac{V_L-a-\bar{b}}{(\sigma^2+\tau^2)^{1/2}}\right) - a\,\Phi\left(\frac{V_L-a}{\sigma}\right)}{\left[1-\Phi\left(\frac{V_L-a-\bar{b}}{(\sigma^2+\tau^2)^{1/2}}\right)\cdot\lambda\right] + \left(a+\bar{b}\right)\Phi'\left(\frac{V_L-a-\bar{b}}{(\sigma^2+\tau^2)^{1/2}}\right)\cdot\frac{\lambda}{(\sigma^2+\tau^2)^{1/2}}} \tag{9}$$

Recall that $\bar{b}$ is on the interval $\left(0,\ \frac{(a-V_L)\left[(\sigma^2+\tau^2)^{1/2}-\sigma\right]}{\sigma}\right)$. This corresponds with the case $\frac{V_L-a-b}{(\sigma^2+\tau^2)^{1/2}} > \frac{V_L-a}{\sigma}$. Therefore, the numerator of (9) is positive. In the denominator of (9), the first term $\left[1-\Phi\left(\frac{V_L-a-\bar{b}}{(\sigma^2+\tau^2)^{1/2}}\right)\cdot\lambda\right]$ is the probability that the project continues to date 2, which is positive. $\Phi'\left(\frac{V_L-a-\bar{b}}{(\sigma^2+\tau^2)^{1/2}}\right)$ in the second term is the derivative of CDF of standard normal distribution. The properties of normal distribution show that the derivative of CDF of standard normal distribution is equal to standard normal PDF. This implies that $\Phi'\left(\frac{V_L-a-\bar{b}}{(\sigma^2+\tau^2)^{1/2}}\right)$ is positive. In addition, the terms $\left(a+\bar{b}\right)$ and $(\sigma^2+\tau^2)^{1/2}$are positive by assumption, and λ is non-negative. These terms together show that the denominator of (9) is positive. Therefore, we have $\frac{\partial \bar{b}}{\partial \lambda} > 0$, which implies that the threshold $\bar{b}$ increases with shareholder intervention threat λ. Q.E.D.

Proposition 2 implies that as the intervention threat of activist investors in-

early digital cameras were not very profitable due to low picture quality and resolution. Canon Inc. was one of the early firms that pursued the innovation of digital photography, and today has become a dominant company in the digital camera industry. Good innovation opportunities may not be very profitable when they first arise. If shareholder intervention imposes threshold $\bar{b}$, many of these good innovation opportunities will not be pursued.

creases, more innovation projects will be blocked. Firm managers possess less discretion to choose an innovation project, especially to pursue those innovations with low market value at early stage.

In the above analysis, the threat of activist intervention reduces managers' innovation incentives mainly because innovation is often associated with less precise information reflected in stock prices. In a firm's information environment, there might be important information providers (e.g., monitoring institutional investors, financial analysts) who can potentially bridge the information asymmetry between corporate insiders and outside investors and improve stock price efficiency. I further examine the effects of these information providers on managers' incentives to innovate under the threat of activist intervention.

Proposition 3: *The effect of the threat of activist intervention λ on threshold $\bar{b}$ is weaker when a firm has more information providers who can improve price informativeness (τ^2 is reduced) .*

Proof:

To show the interaction effect of information providers, we derive the cross-partial derivative of the threshold $\bar{b}$ with respect to λ and τ^2 in (10).

$$\frac{\partial^2 \bar{b}}{\partial \lambda \partial \tau^2} = \frac{\left(a+\bar{b}\right) \cdot \Phi'\left(\frac{V_L - a - \bar{b}}{(\sigma^2+\tau^2)^{1/2}}\right) \cdot \left(\frac{a+\bar{b}-V_L}{2}\right) \frac{1}{\sqrt{(\sigma^2+\tau^2)^3}}}{\left\{\left[1 - \Phi\left(\frac{(V - a - \bar{b}}{(\sigma^2+\tau^2)^{1/2}}\right) \cdot \lambda\right] + \left(a+\bar{b}\right) \Phi'\left(\frac{V_L - a - \bar{b}}{(\sigma^2+\tau^2)^{1/2}}\right) \cdot \frac{\lambda}{(\sigma^2+\tau^2)^{1/2}}\right\}^2} \tag{10}$$

By assumption, $V_L < a$. It follows that the term $\left(\frac{a+\bar{b}-V_L}{2}\right)$ in the numerator of (10) is positive. In addition, the terms $\left(a+\bar{b}\right)$, $\Phi'\left(\frac{V_L-a-\bar{b}}{(\sigma^2+\tau^2)^{1/2}}\right)$ and $\frac{1}{\sqrt{(\sigma^2+\tau^2)^3}}$ are positive. Thus, the cross-partial derivative is positive. Q.E.D.

Proposition 3 shows that when there are more information providers in a firm's information environment, which leads to stock prices being more precisely reflect the value of innovation projects (lower τ^2), the negative impacts of activist threat on corporate innovation will be alleviated.

2.3.3 Empirical Implications

The theoretical model shows that when firm managers decide on whether to pursue innovation, the threat of activist intervention imposes a threshold $\bar{b}$, which makes firm managers refrain from pursuing some innovation projects. A higher threshold $\bar{b}$ means that a larger proportion of innovation projects will be blocked. While we cannot directly observe $\bar{b}$, we can empirically examine the relationship between the threat of activist intervention and corporate innovation outcome. Based on propositions 1 and 2, the threat of activist investors negatively affects manager's incentives to pursue innovation. Thus, I test the following hypothesis:

Hypothesis 1*: The threat of activist intervention negatively affects firm innovation.*

Proposition 3 implies that the effects of activist threat on firm innovation will be reduced when a firm has more information providers on the market who can help incorporate the information about innovation projects into stock price. I examine the roles of monitoring institutional investors and financial analysts, as previous literature shows that these information providers are associated with the information efficiency of a firm's stock price.

Institutional investors are important information providers on the financial market. Boehmer and Kelley (2009) demonstrate that stocks with greater institutional ownership are priced more efficiently, and both institutional holdings and institutional trading activities contribute to the information efficiency of stock prices. Piotroski and Roulstone (2004) provide evidence that institutional investors help accelerate the incorporation of firm-specific earnings news into stock prices. According to Chen, Harford, and Li (2007), among all institutional investors, independent institutions with long-term investments specialize in monitoring firm management. These "monitoring institutional investors" are more likely to obtain information about the value of the innovation projects, and convey that information to the stock market. When monitoring institutional investors help improve stock price efficiency, innovation projects are less likely to be intervened, as intervention is now based on more precise information. As a result, firm managers will have more incentives to innovate.

Besides improving stock price efficiency, monitoring institutional investors have more roles to play. When monitoring institutional investors are actively involved in intervention activities, they can rely on their own private information rather than the information contained in the stock prices to make intervention decisions. This helps relieve firm managers from the intervention pressure caused by imprecise information in stock prices. When monitoring investors do not pursue shareholder activism, their information can be pivotal to the outcome of other investors' intervention activities. An activist shareholder often needs to unite with other shareholders to win an activism campaign. If the monitoring investors have information that a manager's innovation project can greatly improve shareholder value in the long run, monitoring investors will not support the activism campaign or may even defeat activist shareholder attempts. This role is particularly important for firms in which special interest groups take activism to promote their own interest at the expense of other shareholders. Overall, monitoring institutional investors can help promote manager incentives to pursue valuable innovation projects when the managers are under shareholder intervention threat. Thus, I hypothesize that:

Hypothesis 2a: *Among firms with higher holdings by monitoring institutional investors, activist intervention threat has a less negative effect on firm innovation.*

Financial analysts are another group of important information intermediaries between corporate managers and financial market investors. These analysts devote their resources to gather information about a firm's earnings prospects. Frankel and Li (2004) show that an increase in financial analysts that follow a firm is associated with reduced information asymmetry between insiders and outsiders. Similarly, Piotroski and Roulstone (2004) find that analyst forecasting activity accelerates the incorporation of the industry and firm-specific information into stock prices. Financial analysts improve stock price efficiency through their firm-specific earnings forecasts and stock recommendations, and through identifying earnings news that are common to a specific industry. When a firm is followed by more financial analysts, firm managers would expect that the value of their innovation projects is more likely to be incorporated into stock prices, and they are less likely to face intervention. Thus, firm managers will be less inclined to be biased against an innovation project when they are under intervention threat. Following this logic, I hypothesize that:

Hypothesis 2b*: When firms are followed by more financial analysts, activist intervention threat has a less negative effect on firm innovation.*

2.4. Data and Variable Measurement

I construct a firm-level panel dataset with data on innovation, shareholder intervention threat, shareholder monitoring, and financial analysts using a variety of sources. The starting point is the Compustat database, which contains basic financial and accounting data for all U.S. publicly listed firms since 1950. Innovation is measured using patent statistics. Patent data are manually collected from the Thomson Innovation database. The measure of shareholder intervention threat is constructed by combining the activist investor information from FactSet's corporate activism database with the ownership data from Thomson Reuters Institutional (13F) Holdings Database. Financial analyst information is obtained from the Institutional Brokers' Estimate System (I/B/E/S) Database. The final sample consists of an unbalanced panel of 2097 publicly-traded firms. These firms have at least one patent application during the sample period. The explanatory variables are constructed using data from 2001-2008. The dependent variables of innovation are constructed using patent data from 2001-2013.

Firm Innovation

Patents and patent statistics have been widely used as indicators of innovation (Griliches, 1990). The first measure of innovation in this study is the total number of patent applications filed by a firm in a given year (*Total Patents*). Patent application year, rather than patent grant year, is used to capture the time of innovation (Griliches, Pakes, and Hall, 1988). Patents vary in their value and impact. Prior literature suggests that patents of greater economic value were cited more frequently in subsequent patents (Trajtenberg, 1990; Harhoff, *et al.*, 1999). A second innovation measure is the count of highly-cited patents (*Highly-Cited Patents*). Firms with more highly-cited patents tend to have more original, influential inventions, and have larger share of the leading-edge technologies in their industry. To identify highly-cited patents, I calculate the median of the forward citations of all the patents in an industry (4-digit SIC industry) that are filed in a given year, and then localize the patents whose forward citations are higher than the median number of citations in its respective industry. For each firm, I count the number of highly-cited patents.

Patent and citation data were manually collected from the Thomson Innovation database. Thomson Innovation, launched by Thomson Reuters in 2007, is a comprehensive and integrated patent search and analysis platform. The database provides access to patent information from all major patenting authorities worldwide and the Derwent World Patents Index. Its collection of U.S. granted patents covers the years from 1836 to present, and the patents granted by the U.S. Patent and Trademark Office (USPTO). Based on Thomson Innovation, I obtain the patent portfolio for 2097 U.S. publicly-traded firms, with patent data up to 2013. The information includes patent assignee name, application date, publication date, count of forward citations, the publication number of the citing patents, patent class, name of inventor, etc.

A truncation problem exists in the database: many patents that have been filed, but have not yet been granted by USPTO, are not included in the database. As noted in the literature on innovation (e.g., Hall, Jaffe, and Trajtenberg, 2005), there is a significant lag (an average of two years) between patent applications and patent grants. As we approach the last year of the patent database, we observe only a fraction of all patents that have been filed. So, following Hall, Jaffe, and Trajtenberg (2001, 2005), the truncation bias is corrected by constructing "weight factors" based on the application-grant empirical distribution.

Shareholder Intervention Threat

In publicly-traded firms, shareholder intervention activities are often performed by activist institutional investors. The broad category of activist investors include pure-play activists and multi-strategy funds.[3] The pure-play activists specialize exclusively in activism, and pressure for firm change through concentrated stake in a company. The multi-strategy investors are typically diversified and use several strategies within the same pool of assets. These investors have broadened their traditional passive investment model to include more activist-oriented approach.

I measure the threat of shareholder intervention by the percentage of firm outstanding shares held by the activist institutional investors. First, I classify firm institutional investors into activist and non-activist groups. If an investor has activism campaigns (against any U.S. incorporated firms) in the current year or in the previous one year, the investor is categorized as an activist investor. Second, I identify activist investors based on FactSet's corporate activism database, SharkWatch. The database provides activist investor profiles with detailed information on their previous campaigns, tactics, and outcome. It tracks various types of activist investors, including investment advisors, mutual funds, pension funds, hedge funds, labor unions, and other institutions and stakeholders. I obtain the names of the activist investors from the SharkWatch database, and search these names in the Thomson Reuters Institutional Holdings (13F) Database. This procedure identifies 259 activist institutional investors who have at least one shareholder activism campaign during 2001-2008. Finally, for each publicly-traded firm, I aggregate the

[3] See the J.P. Morgan report "The Activist Revolution: Understanding and Navigating a New World of Heightened Investor Scrutiny" (January 2015).

13F holdings of all its activist investors, which gives us the basic measure of the threat of shareholder intervention.[4] For robustness check, I construct additional measures of shareholder intervention threat by requiring an activist investor to have at least 1% ownership, or alternatively 5% ownership in a firm, rather than including all activist investors of a firm.

Shareholder Monitoring

Chen, Harford, and Li (2007) show that among all institutional investors, the independent investors with long-term investments specialize in monitoring the firm. The extent of shareholder monitoring is measured by the percentage of firm outstanding shares held by these "monitoring investors". Following Chen, Harford, and Li, the "independent" investor group includes investment companies, independent investment advisors, and public pension funds. "Long-term investment" is defined as a firm holding shares for greater than one year. Bushee (1998) analyzes the investment patterns of institutions, and classifies institutional investors into three categories: dedicated, quasi-indexer, and transient. Dedicated institutions and quasi-indexers are most likely to perform the monitoring role. As in Chen, Harford, and Li, the "monitoring investors" are constructed by intersecting the group of independent institutions holding long-term investments with Bushee's (1998) categories of dedicated investors and quasi-indexer investors. I focus on

[4] A limitation of this measure is that if an activist investor is not a 13F institutional investor, its influence in the firm is not captured by the measure.

the monitoring activities of non-activist shareholders and their information effect. I select the monitoring investors that did not have activism campaigns (against any U.S. incorporated firms) in the past five years. Their ownership data are obtained from the Thomson Reuters Institutional Holdings (13F) Database. The final measure of shareholder monitoring is constructed by aggregating the 13F holdings of a firm's non-activist monitoring investors.

Analyst Following

The intensity of information collection by a firm's financial analysts is proxied by the number of financial analysts following the firm. Financial analyst data are retrieved from the Thomson Reuters I/B/E/S Detail History file. For each firm in each calendar year, I calculate the maximum number of financial analysts that make one-year-ahead forecasts. Firms that are not covered by the I/B/E/S database are assumed to have no analyst coverage.

Control Variables

As in the innovation literature, I control for firm-specific and industry characteristics that may affect firm innovation. I control for firm size, which is proxied by a firm's book value of total assets (*Assets*). Firms with greater growth opportunities are more likely to innovate. Firm growth opportunities are measured by Tobin's Q. Since firm innovation tends to affect stock market value, Tobin's Q will be endogenous in the regression. To address this concern, I include the industry median Tobin's Q ("industry Q") to control for the investment opportunities at the industry (4-digit SIC code) level. Since innovation is directly related to firm investment level, firm capital expenditure (scaled by total assets) is included as a control. I also control for firm profitability (measured by return-on-assets ratio (ROA)), asset tangibility (measured by net properties, plants, and equipment (PPE), scaled by total assets), financial leverage (measured by the ratio of debt to total firm value), and financial constraints (proxied by Kaplan and Zingales (1997) five variable KZ index).

Firm innovation activities may vary with firm age. Balasubramanian and Lee (2008) show that firm age is negatively related to innovation quality. They argue that organizational inertia and reduced learning rates associated with older firms are the main reasons for the decline in innovation quality. Firm age is approximated by the number of years a firm is listed in the Compustat database. Aghion, *et al.* (2005) propose that product market competition discourages laggard firms from innovating but encourages neck-and-neck firms to innovate. They find an inverted-U relationship between a firm's product market competition and innovation. Product market competition (measured by the Herfindahl sale index) is included as a control. Industry fixed effects are controlled by including industry dummies. The definition of industry is based on the SIC 3-digit code. The variables *Assets, ROA, CapExp/Assets, PPE/Assets, Leverage,* and *KZIndex* have many outliers. To minimize the effect of outliers, these variables are winsorized at the 1^{st} and 99^{th} percentiles. Detailed variable definitions are provided in Table 2.1.

Summary Statistics

In Table 2.2, I report the summary statistics of the variables used in this study. The innovation variables *Total Patents* and *Highly-Cited Patents* are highly skewed. For *Total Patents*, the mean is 39.2, but the median is 3. Similarly, the mean of *Highly-Cited Patents is* 17.1, but the median is 1. For an average firm in the sample, 3.3% of the outstanding shares of the firm are held by activist institutional investors, 23.4% of the firm shares are held by non-activist monitoring investors, and the firm is followed by about 9 financial analysts. The measure of firm size, *Assets,* is also skewed, with a mean of 6.4 billion, and a median of 421 million. Regarding other variables, an average firm has a return-on-assets ratio of 0.02, a capital expenditure-to-assets ratio of 0.045, a PPE-to-assets ratio of 0.214, a leverage ratio of 0.273, a KZ Index of -11.187, and is 20 years old. At the industry (4-digit SIC) level, an average firm's industry Q is 2.105, and the average Herfindahl sale Index is 0.225.

Table 2.1. Variable Definition

Variables	Definition	Data Source
Total Patents$_{t+n}$	Firm i's total number of patent applications filed (and eventually granted) in year $t+n$.	Thomson Innovation Database
Highly-Cited Patents$_{t+n}$	Firm i's number of highly cited patents that are filed (and eventually granted) in year $t+n$. I first construct the median of the forward citations of all the patents in an industry, and then identify the patents whose forward citations are higher than the median number of citations in its respective industry in a given year.	Thomson Innovation Database
Shareholder Intervention Threat$_t$	The percentage of firm i's outstanding shares held by the group of activist institutional investors. An institutional investor is defined as activist investor if the investor has activism campaigns (against any U.S. incorporated firms) in the current year or in the previous one year.	FactSet's corporate activism database, SharkWatch; Thomson Reuters Institutional Holdings (13F) Database.
Shareholder Monitoring$_t$	The percentage of firm i's outstanding shares held by non-activist, monitoring institutional investors. The monitoring institutional investors are constructed by intersecting the group of independent institutions holding long-term investments with Bushee's (1998) categories of dedicated investors and quasi-indexer investors.	Thomson Reuters Institutional Holdings (13F) Database.
Analysts$_t$	The number of financial analysts that make one-year ahead forecasts for firm i at year t.	Thomson Reuters I/B/E/S Detail History file
Assets$_t$	Firm i's book value of total assets (item # 6)	Compustat
Market Value$_t$	Firm i's market value of equity (item #25 × item # 199)	Compustat
Tobin's Q_t	Firm i's Tobin's Q is computed as [market value of equity (item # 199×iterm # 25) + book value of assets (item # 6) − book value of equity (item #60) −balance sheet deferred taxes (item #74)] /book value of assets (item # 6)	Compustat
Industry Q_t	The median of the Tobin's Q of all firms in an industry (by 4-digit SIC code).	Compustat
ROA$_t$	Operating income before depreciation (item # 13) divided by lagged assets (item # 6)	Compustat
CapExp / Assets$_t$	Capital expenditure (item # 128) divided by lagged asset (item # 6)	Compustat
Leverage$_t$	Book value of debt (item #9 + item #34)/[Book value of debt (item #9 + item #34)+Stockholders' Equity (item #216)]	Compustat
KZIndex$_t$	Firm i's Kaplan and Zingales index measure is calculated as -1.002×Cash Flow + 0.283×Tobin's Q + 3.139×Leverage - 39.368×Cash Dividends - 1.315×Cash Holdings. Cash flow is calculated as [(item #18+item #14)/item #8], dividends is calculated as [(item #21+item #19)/item #8], and cash holdings is calculated as [item #1/item #8], where item #8 is lagged. Tobin's Q and Leverage are defined above.	Compustat
PPE/Assets$_t$	Property, Plant & Equipment (item # 8) divided by lagged asset (item # 6)	Compustat
Firm Age$_t$	Firm *i's* age in year t, approximated by the number of years listed on Compustat.	Compustat
Herfindahl Index$_t$	Herfindahl Hirschman Index, defined as the sum of squared market shares, constructed based on sales at 4-digit SIC industries.	Compustat
Cash/Assets	Cash (item #1) / total assets (item # 6)	Compustat
Net Short-term Debt	[Short-term Debt (item # 34)-Cash (item #1)] /total assets (item # 6)	Compustat

Table 2.2
Summary Statistics

Variables	5%	25%	Median	75%	95%	Mean	SD	N
Total Patents	0	0	3.002	13.078	149.735	39.230	178.496	13414
Highly-Cited Patents	0	0	1.031	6.085	65.935	17.098	77.459	13414
Activist Investor Ownership	0	0.001	0.008	0.040	0.149	0.033	0.056	13414
Monitoring Investor Ownership	0.003	0.087	0.231	0.350	0.513	0.234	0.165	13362
Analysts	0	2	6	13	29.25	9.121	9.591	13014
Assets (in Millions)	12.9	82.3	421.0	2503.0	30356.3	6429.0	21696.7	13414
Tobin's Q	0.692	1.191	1.789	2.959	7.858	2.928	6.045	13414
Industry Q	0.956	1.354	1.798	2.533	3.881	2.105	2.568	13414
ROA	-0.528	-0.029	0.095	0.169	0.304	0.020	0.298	13414
CapExp / Assets	0.004	0.016	0.031	0.055	0.141	0.045	0.049	13414
PPE / Assets	0.018	0.069	0.153	0.291	0.644	0.214	0.198	13414
Leverage	0	0.003	0.189	0.421	0.837	0.273	0.342	13414
KZIndex	-47.220	-8.169	-2.250	0.339	3.337	-11.187	38.607	13414
Firm Age	4	9	14	27	54	19.988	15.410	13414
Herfindahl Index	0.058	0.096	0.172	0.279	0.606	0.225	0.185	13414

2.5. Empirical Results

2.5.1 The Effects of the Threat of Shareholder Intervention on Firm Innovation

To examine the effects of shareholder intervention threat on firm innovation, I estimate the empirical model in (11):

$$E(Innovation_{i,t+n}|X_{i,t},\, \nu_k,\, \mu_t,\, \eta_i) = \exp(\beta_0+\beta_1\times Intervention\,Threat_{i,t}+\gamma X_{i,t}+\nu_k+\mu_t+\eta_i) \tag{11}$$

Here, $Innovation_{i,t+n}$ is firm i's innovation performance at year $t+n$. Innovation projects on average take two years to yield successful, patentable technologies. I examine firm innovation outcome from year $t+1$ to year $t+4$, with a focus on the innovation outcome at year $t+2$. $Intervention\,Threat_{i,t}$ represents the level of shareholder intervention threat of firm i at year t, and is measured by the percentage of firm outstanding shares held by the group of activist institutional investors. $X_{i,t}$ are control variables, ν_k is an industry fixed effect, μ_t is a year fixed effect, and η_i is a firm fixed effect. Equation (11) adopts the log-link formulation because of the non-negative and highly skewed nature of the count-based data.

OLS and negative binomial estimators are applied to estimate (11). I perform an overdispersion test on the patent data (Cameron and Trivedi, 2005, 2009), and the test results indicate the presence of considerable overdispersion in our data. A negative binomial estimator, which explicitly models overdispersion, is appropriate in this situation. As in Blundell, Griffith, and Van Reenen (1999), and Aghion, Van Reenen, and Zingales (2013), I control for firm fixed effects η_i using the "presample mean scaling" method. Specifically, I use a firm's average number of patents (and highly-cited patents) over the presample period as a proxy for unobserved heterogeneity. This method controls for permanent differences in a firm's propensity to innovate. Year fixed effects and industry fixed effects are controlled by including year dummies and industry dummies (constructed based on 3-digit SIC code). Standard errors are clustered at the firm level to avoid inflated t-statistics.

In Table 2.3, I report the estimated effects of shareholder intervention threat on firm innovation at year $t+2$. Columns (1) and (2) include the OLS estimates, where the dependent variable ln($Total\ Patents_{t+2}$) is the natural logarithm of one plus the total number of patents applied by firm i at year $t+2$, and ln($Highly\text{-}Cited\ Patents_{t+2}$) is the natural logarithm of one plus the number of patents applied by

Table 2.3: The Effects of Shareholder Intervention Threat on Firm Innovation

This table shows the pooled OLS and negative binomial estimates of the effects of shareholder intervention threat on firm innovation. The main explanatory variable *Intervention Threat* is measured by the percentage of firm outstanding shares held by activist institutional investors. Firm fixed effects are controlled using the "presample mean scaling" method, following the procedure in Blundell, Griffith, and Van Reenen (1999). Robust standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Model	OLS	OLS	Negative Binomial	Negative Binomial
Dependent Variable	ln (*Total Patents*$_{t+2}$)	ln (*Highly-Cited Patents*$_{t+2}$)	*Total Patents*$_{t+2}$	*Highly-Cited Patents*$_{t+2}$
	(1)	(2)	(3)	(4)
Intervention Threat	**-0.962*** **	**-0.823*** **	**-1.239*** **	**-0.921** **
	(0.311)	(0.276)	(0.423)	(0.467)
ln *(Assets)*	0.289***	0.220***	0.500***	0.457***
	(0.018)	(0.016)	(0.025)	(0.026)
Industry Q	0.005	0.005	0.008	0.012
	(0.004)	(0.004)	(0.008)	(0.008)
ROA	-0.075	-0.053	-0.299***	-0.225**
	(0.063)	(0.054)	(0.097)	(0.109)
CapExp / Assets	2.177***	1.838***	3.403***	3.611***
	(0.381)	(0.332)	(0.581)	(0.644)
PPE / Assets	-0.431***	-0.315**	-0.890***	-0.870***
	(0.153)	(0.131)	(0.224)	(0.246)
Leverage	-0.250***	-0.210***	-0.270***	-0.289***
	(0.048)	(0.042)	(0.070)	(0.079)
KZIndex	-0.000	-0.000	0.001	0.000
	(0.000)	(0.000)	(0.001)	(0.001)
ln *(Firm Age)*	-0.133***	-0.104***	-0.226***	-0.236***
	(0.032)	(0.029)	(0.043)	(0.047)
Herfindahl Index	-0.569	-0.490	-0.601	-0.551
	(0.387)	(0.344)	(0.550)	(0.594)
Herfindahl Index ^{2}	0.181	0.214	-0.195	-0.238
	(0.438)	(0.385)	(0.622)	(0.659)
Constant	-0.277*	-0.346***	-1.998***	-2.308***
	(0.142)	(0.126)	(0.555)	(0.562)
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	13414	13414	13414	13414

firm i at year $t + 2$ that received a higher amount of citations (than the industry median) in subsequent years. The coefficients on shareholder intervention threat are negative and statistically significant. It shows that a ten percentage point increase in activist investor ownership (e.g., from the median of 0.008 to 0.108) is associated with a 9.6% decrease in the total number of patents and an 8.2% decrease in the number of highly-cited (highly influential) patents. In Columns (3) and (4), I report the results of the negative binomial estimations, with *Total Patents*$_{t+2}$ and *Highly-Cited Patents*$_{t+2}$ being the dependent variables. The coefficients on shareholder intervention threat remain significant with a larger marginal effect. These results show that the threat of shareholder intervention negatively affects firm innovation incentives. In Appendix Table A1, I present the estimated effects of shareholder intervention threat (at time t) on firm innovation performance from $t + 1$ to $t + 4$. The estimation results are qualitatively similar over the four years, although the effects decline slightly for years $t + 3$ and $t + 4$.

The results are robust to using alternative measures of shareholder intervention threat. The primary measure of intervention threat used in Table 2.3 is constructed by aggregating the 13F holdings of all activist institutional investors in a firm. Alternatively, we can select activist institutional investors who own more than 1% of firm outstanding shares, or own more than 5% of firm outstanding shares. As shown in Appendix Table A2, the results are similar using a different share ownership threshold. For example, the marginal effect of shareholder intervention threat is -0.993 based on activist institutional investors who have at least 1% ownership, and is -0.987 based on activist investors who have at least 5% ownership. When including all activist institutional investors of a firm, the marginal effect is -0.962 (Table 2.3). I also examine whether the effect of shareholder intervention threat on innovation is monotonic. In an untabulated analysis, I include a quadratic term for $Intervention\,Threat_{i,t}$ in equation (11), and rerun the regressions. The coefficient on the square of $Intervention\,Threat_{i,t}$ is not statistically significant.

2.5.2 Shareholder Monitoring and Analyst Following

This research highlights the information roles of institutional investors and financial analysts. I propose that when "monitoring" institutional investors and financial analysts help incorporate innovation-related information into stock price, improving price efficiency, the negative effects of shareholder intervention threat on firm innovation will be reduced. The information roles of monitoring institutional investors and financial analysts are particularly important for the firms that are less transparent and suffer more from the information asymmetry problem.

To examine this possibility, I estimate empirical models in (12) and (13) using OLS and negative binomial methods:

$$E(Innovation_{i,t+n}|X_{i,t},\,\nu_k,\,\mu_t,\,\eta_i) = \exp(\beta_0+\beta_1\times Intervention\,Threat_{i,t}+\beta_2\times Shareholder\,Monitoring_{i,t} + \beta_3\times Intervention\,Threat_{i,t}\times Shareholder\,Monitoring_{i,t}+\gamma X_{i,t}+\nu_k+\mu_t+\eta_i) \quad (12)$$

$$E(Innovation_{i,t+n}|X_{i,t},\,\nu_k,\,\mu_t,\,\eta_i) = \exp(\beta_0+\beta_1\times Intervention\,Threat_{i,t}+\beta_2\times Analyst\,Following_{i,t} + \beta_3\times Intervention\,Threat_{i,t}\times Analyst\,Following_{i,t}+\gamma X_{i,t}+\nu_k+\mu_t+\eta_i) \quad (13)$$

Here, $Shareholder\ Monitoring_{i,t}$ indicates the level of shareholder monitoring, which is measured by the percentage of firm outstanding shares held by the group of non-activist, monitoring institutional investors. $Analyst\ Following_{i,t}$ represents the intensity of information collection by financial analysts, and is proxied by the number of financial analysts following the firm.[5] The information effects of monitoring institutional investors and financial analysts are tested in a subsample of firms that are more likely to suffer from information asymmetry problem. I sort firms into quintiles based on market capitalization, and retain firms in the lower quintiles. Firms with large market capitalization have greater visibility and less information asymmetry. The roles of monitoring institutional investors and financial analysts in bridging information asymmetry will be greater for small capitalization firms than for large firms.

Table 2.4 reports the estimated interaction effects of shareholder monitoring and analyst following, respectively. Coefficients in columns (1), (3), (5), and (7) show a positive and significant interaction effect of shareholder monitoring, implying that the monitoring activities of non-activist shareholders mitigate the negative effects of shareholder intervention threat on firm innovation. Using the estimation result in column (1) as an example, the estimated interaction effect of shareholder monitoring is 4.544. Consider a firm in which 8.7% of firm outstand-

[5] $Shareholder\ Monitoring_{i,t}$ and $Analyst\ Following_{i,t}$ are highly correlated, with a Pearson's correlation coefficient equal to 0.526. This means that firms that have more monitoring institutional investors tend to have more analysts that follow the firms and make forecasts.

Table 2.4: Shareholder Monitoring and Analyst Following

Model	OLS		OLS		Negative Binomial		Negative Binomial	
Dependent Variable	ln (*Total Patents*$_{t+2}$)		ln (*Highly-Cited Patents*$_{t+2}$)		*Total Patents*$_{t+2}$		*Highly-Cited Patents*$_{t+2}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intervention Threat	-1.711***	-1.987***	-1.329***	-1.570***	-2.467***	-2.657***	-2.130***	-2.521***
	(0.392)	(0.438)	(0.345)	(0.381)	(0.671)	(0.692)	(0.706)	(0.720)
Shareholder Monitoring	-0.210		-0.221*		-0.118		-0.045	
	(0.130)		(0.115)		(0.178)		(0.191)	
Intervention Threat × *Shareholder Monitoring*	**4.544*** **		**3.279*** **		**5.680** **		**5.050** **	
	(1.425)		(1.265)		(2.391)		(2.346)	
ln *(Analysts)*		0.055**		0.021		0.114***		0.099***
		(0.026)		(0.022)		(0.034)		(0.036)
Intervention Threat × ln *(Analysts)*		**0.783*** **		**0.592*** **		**0.864** **		**0.901** **
		(0.235)		(0.205)		(0.381)		(0.373)
ln *(Assets)*	0.242***	0.207***	0.181***	0.160***	0.439***	0.379***	0.395***	0.339***
	(0.018)	(0.021)	(0.016)	(0.018)	(0.027)	(0.029)	(0.028)	(0.030)
Industry Q	0.001	0.001	0.002	0.002	0.003	0.003	0.011	0.009
	(0.004)	(0.004)	(0.003)	(0.003)	(0.019)	(0.019)	(0.020)	(0.019)
ROA	-0.029	-0.042	-0.010	-0.018	-0.209**	-0.242**	-0.133	-0.153
	(0.057)	(0.061)	(0.047)	(0.051)	(0.098)	(0.098)	(0.107)	(0.109)
CapExp / Assets	1.615***	1.461***	1.373***	1.308***	2.425***	2.065***	2.556***	2.212***
	(0.352)	(0.370)	(0.302)	(0.320)	(0.593)	(0.614)	(0.688)	(0.707)
PPE / Assets	-0.284**	-0.171	-0.195	-0.125	-0.542**	-0.289	-0.464*	-0.228
	(0.143)	(0.150)	(0.120)	(0.125)	(0.234)	(0.243)	(0.267)	(0.274)
Leverage	-0.191***	-0.197***	-0.151***	-0.156***	-0.204***	-0.199***	-0.222***	-0.211**
	(0.046)	(0.048)	(0.039)	(0.042)	(0.070)	(0.071)	(0.082)	(0.083)
KZIndex	-0.000	-0.000	-0.000	-0.000	0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
ln *(Firm Age)*	-0.112***	-0.094***	-0.085***	-0.077**	-0.185***	-0.154***	-0.205***	-0.177***
	(0.034)	(0.036)	(0.029)	(0.031)	(0.048)	(0.049)	(0.052)	(0.053)
Herfindahl Index	-0.728**	-0.674*	-0.669**	-0.647*	-0.705	-0.632	-0.624	-0.530
	(0.371)	(0.380)	(0.324)	(0.333)	(0.595)	(0.605)	(0.650)	(0.662)
Herfindahl Index ^{2}	0.348	0.290	0.372	0.341	-0.083	-0.118	-0.250	-0.309
	(0.426)	(0.434)	(0.360)	(0.369)	(0.719)	(0.738)	(0.777)	(0.801)
Year FE, Firm FE, Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10682	10375	10682	10375	10682	10375	10682	10375

ing shares are held by monitoring institutional investors (at the 25th percentile of the shareholder monitoring distribution). Increasing the firm's intervention threat (proxied by activist investor ownership) from the median value of 0.008 to the 90 percentile value of 0.102, leads to a decrease in firm innovation by 12.4% ($= [-1.711 + 4.544 \times 0.087] \times [0.102 - 0.008]$). In contrast, for a firm that has 35% of outstanding shares held by monitoring institutional investors (at the 75th percentile of the shareholder monitoring distribution), increasing intervention threat from the median value of 0.008 to the 90 percentile value of 0.102, leads to a decrease in firm innovation by 1.1% ($= [-1.711 + 4.544 \times 0.35] \times [0.102 - 0.008]$). Overall, at the higher levels of shareholder monitoring, the threat of shareholder intervention exerts less negative effect on firm innovation.

The estimated interaction effects of analyst following are reported in columns (2), (4), (6), and (8) of Table 2.4. The coefficients on the interaction term $InterventionThreat \times ln(Analysts)$ are positive and statistically significant in all four columns. This means that firms followed by more analysts are less likely to forego innovation in response to increasing threat of shareholder intervention. Taking the results in column (2) as an illustration of this effect, the estimate of the interaction effect of analyst following is 0.783. Consider a firm that is followed by only 2 financial analysts (at the 25th percentile of the analyst following distribution). An increase of intervention threat level from the median value of 0.008 to the 90 percentile value of 0.102, is associated with a drop in firm innovation by

10.6% ($= [-1.987 + 0.783 \times 1.099] \times [0.102 - 0.008]$). However, when the number of analysts following the firm increases to 13 (at the 75th percentile of the analyst following distribution), increasing intervention threat does not significant affect firm innovation. These results basically support the hypothesis that financial analysts help mitigate the negative effects of shareholder intervention threat on firm innovation.

2.6 Quasi-Natural Experiment of Activist Investor Closures

In the empirical analysis of Section 2.5, the negative coefficients in the regressions of firm innovation on shareholder intervention threat support the hypothesis that the intervention threats negatively affect firm manager innovation incentives. A major concern is that less innovative firms may attract more activist institutional investors and, thus, a higher level of intervention threat. To address this reverse causality concern, I adopt an identification strategy that relies on a quasi-natural experiment of activist investor closures to generate exogenous variation in levels of shareholder intervention threat. For this natural experiment to be valid, two conditions must be satisfied. First, activist investor closures must correlate with a decrease in shareholder intervention threat (relevance condition). Second, activist investor closures must only affect firm innovation through their effect on shareholder intervention threat (exogeneity condition). Section 2.6.1 discusses the main reasons for activist investor closures, and explains why the closure events are plausibly exogenous. Section 2.6.2 examines the magnitude of the intervention threat change caused by activist investor closures.

2.6.1 The Closures of Activist Institutional Investors

Activist institutional investors often undertake intervention activities, and their shareholdings constitute a real threat to firm managers. During the 2007-2009 financial crisis, a large portion of activist institutional investors closed their businesses.[6] For example, Tim Barakett, the founder of Atticus Capital and "one of the fathers of modern hedge fund activism", closed down two flagship activist funds in 2009,[7]and returned approximately $3 billion to investors (*Financial Times*, August 12, 2009). Among activist institutional investors, the closure events concentrated on activist hedge funds. In the financial crisis period, the whole hedge fund industry experienced a liquidity crisis. Investor confidence in the world's financial market and in hedge funds fell dramatically, especially after the collapse of Lehman Brothers Holdings, Inc. in 2008. Many hedge funds received substantial redemption requests from the fund investors, even when fund performance remained relatively strong. According to *New York Law Journal* (March 2, 2009),

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Activist investor closure in this paper means that an activist investor winds down its business and investment affairs. In industry parlance, "closure" also refers to funds closing to new investors. The latter type of closure is not the subject of this research.

7

Tim Barakett liquidated Atticus Global and Atticus Trading Funds in 2009. Atticus European Fund continued, which is managed by David Slager. Atticus (the management company) did not have SEC filings after 2009.

in 2008 hedge fund redemption reached nearly $400 billion, and the assets under management by the hedge fund industry declined from $2.2 trillion in mid-2008 to $ 1.3 trillion by the end of 2008.

In the financial crisis period, hedge fund closures were largely driven by market-wide liquidity shocks. Brunnermeier and Pedersen (2009) show that in times of crisis, sharp reductions in asset liquidity (the ease of trading assets) and funding liquidity (the availability of funding) are mutually reinforcing, leading to a liquidity spiral. Boyson, Stahel, and Stulz (2010) demonstrate that these liquidity spirals cause contagion in hedge fund worst returns. As market-wide liquidity shocks led to deteriorating hedge fund performances and increasing redemption requests, a large number of hedge funds chose to close their funds. Ben-David, Franzoni, and Moussawi (2012) provide evidence that hedge funds exited the U.S. stock market en masse in 2008 in response to shocks to funding liquidity.

The characteristics and strategies of activist hedge funds make the performance of these funds more sensitive to liquidity shocks. Hedge funds that are actively involved in shareholder activism (including pure-play activists and multi-strategy funds) often need to have "patient money" to execute their strategies or to win an activism campaign. The fund managers need time to negotiate with corporate board and management, coordinate with other shareholders, and work on transactions such as mergers, acquisitions, and spin-offs. The adverse liquidity shocks and redemption requests may force activist hedge funds to liquidate their positions prematurely. As a result, the returns from the activist strategies cannot be fully realized.

Even when activist funds were not forced to liquidate their positions, the returns from their activist strategies also declined dramatically. Greenwood and Schor (2009) state that activist hedge fund returns "are largely explained by the ability of activists to force target firms into a takeover", and "activist investors' portfolios perform poorly during a period in which market wide takeover interest declined" (p.363). The authors argue that, from the perspective of activist hedge funds, takeovers are an optimal way to exit their sizable position in the target. Before the 2007-2009 financial crisis, pressuring firms for takeover was the most profitable activist strategy, and was pursued by many activist hedge funds.[8] However, during the 2007-2009 financial crisis this takeover strategy became unattractive, as the global mergers and acquisitions markets fell sharply. According to Becht, Franks, Grant, and Wagner (2014), the number of takeovers conducted by activist hedge funds dropped by 57% between 2007 and 2008, and a further 40% between 2008 and 2009. Other activist strategies, such as improving corporate governance and business strategies, also experienced difficulties, and outcomes became unpredictable. Cheffins and Armour (2011) argue that, under normal economic conditions, shareholders are often receptive to activist overtures

[8] Becht, Franks, Grant, and Wagner (2014) show that abnormal returns vary considerably across different types of activist strategies. The average returns is 11 percent for takeover strategy, 7 percent for other forms of restructuring, and zero to 3 percent for strategies related to governance and payout policy.

when a company is performing poorly, while, during financial crisis, shareholders often opt for caution and are reluctant to disrupt the status quo. Patrick McGurn, special counsel to RiskMetrics Group, parent company of proxy advisor ISS Governance Services, commented that "[with uncertainty on the financial market,] concerns about the market and economy trumped concerns about individual management or boards" (*Financial Times*, July 6, 2008).[9]

In sum, in the financial crisis period, the returns of activist investors declined sharply because of the market-wide liquidity shocks and the collapse of the global M&A markets. Combined with increasing redemption requests, many activist hedge funds decided to close and redeem their investors. Activist investor closures are plausibly exogenous, as the closure decisions are unlikely to have been motivated by information on the innovation performance of portfolio firms. In fact, the activist investor closures are concentrated during the financial crisis period, with cases rarely occurring before and after. This implies that the adverse and precipitous economic and market conditions are the main reasons for activist investor closures. The analyses in Section 2.6.3 show that treatment firms and closely matched control firms have parallel innovation performances before the activist investor closures, and this provides supportive evidence that activist investor closures were not driven by the changes in the innovation performances of portfolio firms. Overall, activist investor closures are plausibly exogenous, as required for identification.

[9] See "Shareholder Democracy is on Hold", *Financial Times*, July 7, 2008.

To identify all activist investors that closed between 2007 and 2010, I combine four sources of activist investor information: FactSet's corporate activism database, SEC filings, Hedge Fund Research (HFR) database, and Factiva news. First, I identify the names of activist investors and the history of their activism campaigns from FactSet's corporate activism database. Second, I search the SEC filings and obtain the last filing dates of individual investors. The investors whose last filing dates ended in or before 2011 are included as candidates for closing activist investors. I search for these investors and their key executives in Factiva news to verify closure events. This procedure helps remove the cases in which activist investors changed names and operated under new names, as well as the cases in which investor assets fell below the minimum filing requirement (e.g., $100 million for 13F filings). In addition, I verify investor closures through Hedge Fund Research (HFR) database if the activist investor is a hedge fund. The final sample includes 20 activist institutional investors that closed their businesses in the U.S. between 2007 and 2010. Table 2.5 lists these activist investors. Compared with the years of 2005 and 2006, in which 157 institutional investors actively pursued shareholder activism, about 12.7% of these activist investors closed down.

2.6.2 Identifying Treatment and Control Firms

The purpose of the quasi-natural experiment design is to examine how firm innovation responds following the exogenous changes in the level of shareholder intervention threat. The group of treatment firms are the U.S. publicly-traded

Table 2.5 List of Closed Activist Investors

The table lists the closures of activist institutional investors in 2007-2010. Column (1) provides the name of the closed activist institutional investors, and Column (2) states the year that they closed. Column (3) reports investor type, and Column (4) indicates the number of activism campaigns the investor undertook up to the closure year. The name of the activist institutional investors, their type, and their history of activism campaigns are based on FactSet's corporate activism database, SharkWatch.

Activist Institutional Investors (1)	Closure Year (2)	Investor Type (3)	No. of Activism Campaigns (4)
Sowood Capital Management, LP	2007	Hedge Fund	3
Cadence Investment Management, LLC	2007	Hedge Fund	1
Copper Arch Capital, LLC	2007	Hedge Fund	1
Keefe Managers, LLC	2007	Hedge Fund	1
K Capital Partners, LLC	2008	Hedge Fund	11
Flagg Street Capital, LLC	2008	Hedge Fund	2
Stevenson Capital Management, Inc.	2008	Investment Advisor	1
Trivium Capital Management, LLC	2008	Hedge Fund	1
Pirate Capital, LLC	2009	Hedge Fund	24
Mercury Real Estate Advisors, LLC	2009	Investment Advisor	20
Atticus Capital, LLC	2009	Hedge Fund	18
D.B. Zwirn & Co. LP	2009	Hedge Fund	6
RLR Capital Partners, LP	2009	Hedge Fund	3
Deephaven Capital Management, LLC	2009	Hedge Fund	2
Okumus Capital, LLC	2009	Hedge Fund	2
Vardon Capital Management, LLC	2009	Hedge Fund	2
Shamrock Partners Activist Value Fund LLC	2010	Hedge Fund	41
Duquesne Capital Management, LLC	2010	Hedge Fund	2
Eastbourne Capital Management, LLC	2010	Hedge Fund	2
Obrem Capital Management, LLC	2010	Hedge Fund	2

firms in which one or more of the firm's activist institutional investors closed their funds during 2007-2010. The identification of treatment firms is based on SEC 13F filings, and the data are retrieved from the Thomson Reuters Institutional Holdings (13F) Database. I track the shareholdings of the 20 activist investors two years before their closure. Publicly-traded firms, whose shares (at least 1%) were held by these closing activist investors prior to closure, are defined as the treatment firms. I exclude the firms that do not have patent data. The final sample includes 206 treatment firms.

The control group consists of the U.S. publicly-traded firms that were not affected by activist investor closures. I match treatment firms and control firms by year, industry, firm size, investment opportunities, and intervention threat level. Specifically, the candidate control firms are required to be in the same total assets quintile, Tobin's Q quintile, and from the same year and 3-digit SIC industry as the treatment firms. I calculate the difference in activist investor holdings between each treatment firm and its candidate control firm one year prior to the closure event. For each treatment firm, I retain one candidate control firm that has the smallest difference in activist investor holdings. Both treatment and control firms are required to have Compustat data prior to and after activist investor closures. The final sample includes 206 treatment firms and 206 closely-matched control firms.

To assess how well the control firms match the treatment firms, I compare important firm characteristics in the pre-event year between the treatment group and control group. As displayed in Table 2.6, there are no statistically significant differences between the treatment and control groups for firm size, investment opportunities, shareholder intervention threat, and other important firm characteristics associated with innovation. The only exception is that the treatment firms are slightly younger than the control firms. Importantly, the growth rates in innovation variables are similar between the treatment and control firms. The growth rates in the number of total patents and in the number of highly-cited

Table 2.6: Differences in Firm Characteristics between Treatment Firms and Control Firms

The table reports the pairwise comparison between the treatment and control firms on important firm characteristics, and their corresponding t-statistics. The sample comprises 206 treatment firms that experienced exogenous change in shareholder intervention threat caused by the activist investor closures between 2007 and 2010, and the same number of control firms. Treatment and control firms are matched by calendar year, 3-digit SIC industry, total assets, Tobin's Q, and shareholder intervention threat. Growth rate of total patents and growth rate of highly-cited patents are calculated as the average growth rate over the four years before activist investor closures.

Firm Characteristics	Treatment	Control	Differences	t-statistics
Assets, in billions	5.204	7.021	-1.817	-0.98
Firm Tobin's Q	2.804	2.429	0.375	0.98
Activist Investor Ownership	0.111	0.105	0.006	0.73
Monitoring Investor Ownership	0.290	0.299	-0.009	-0.65
Analysts	11.311	12.273	-0.962	-1.18
ROA	0.004	0.011	-0.007	-0.20
CapExp / Assets	0.046	0.049	-0.003	-0.48
R&D / Assets	0.186	0.178	0.008	0.33
PPE / Assets	0.215	0.193	0.022	0.93
Leverage	0.316	0.262	0.054	1.20
KZIndex	-18.914	-16.920	-1.994	-0.25
Firm Age	17.049	20.058	-3.009	-2.11
Herfindahl Index	0.196	0.199	-0.003	-0.17
Cash / Assets	0.309	0.313	-0.004	-0.16
Net Short-term Debt	-0.267	-0.286	0.019	0.70
Growth Rate of Total Patents	0.033	0.031	0.002	0.03
Growth Rate of Highly-Cited Patents	0.051	0.033	0.018	0.22

patents are computed over the four years prior to the closure events. The data in Table 2.6 confirm that the matching process has removed meaningful differences among the treatment and control firms in the observable firm characteristics.

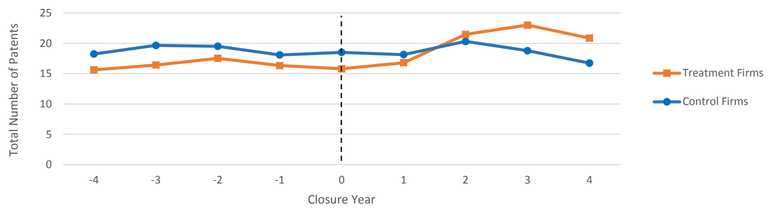
Identification requires that the activist investor closures should generate exogenous variation in the levels of shareholder intervention threat (relevance condition). Following activist investor closures, the total number of activist investors within a firm declined. When activist investors as a group have less ownership, they will have less power to win an activism campaign. Thus, the intervention threat imposed on firm management will decline after activist investor closures. I estimate the magnitude of the intervention threat change following activist investor closures, and I examine the intervention threat level of a firm during the three years before and the three years after the closure event year. The results from difference-in-differences estimation show that the ownership of treatment firms by activist investors decreased by 1.49 percentage points relative to control firms (with a p-value of 0.019). Compared with the pre-closure intervention threat level of the treatment group, activist investor closures caused a reduction of 13.4% in intervention threat. Overall, activist investor closures led to an economically important decrease in the threat of shareholder intervention.

2.6.3 The Effect of Activist Investor Closures on Firm Innovation

The difference-in-differences estimator (DiD) is applied to estimate changes in firm innovation following exogenous changes in the threat of shareholder intervention. The estimator removes common time trends that affect both treatment and control firms, as well as biases that could be the result from permanent differences between the two groups of firms. The key identifying assumption of DiD is that, in the absence of the treatment, the average outcomes for the treatment and control groups would have followed parallel paths over time.

Figure 2 illustrates the innovation paths of the treatment firms and control firms over a nine-year period centered on the year of activist investor closures. Panel A shows the changes in the number of total patents, and Panel B presents

Panel A: Changes in Total Patents Surrounding Activist Investor Closures



Panel B: Changes in Highly-Cited Patents Surrounding Activist Investor Closures

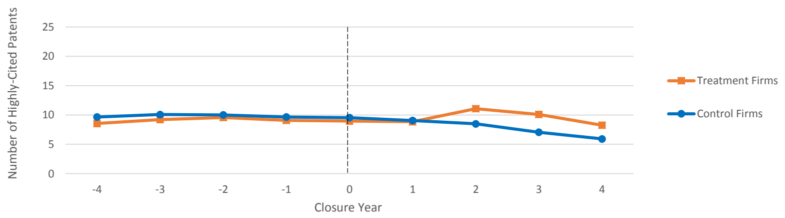


Figure 2: Innovation Paths of Treatment and Control Firms

Notes: This figure illustrates the innovation of treatment firms and control firms from four years before activist investor closures to four years after the closure events. Panel A presents the changes in the number of total patents surrounding activist investor closures, and Panel B shows the changes in the number of highly-cited patents. For each year, I calculate the mean of the innovation variables across treatment firms and across control firms, respectively. Treatment group consists of 206 U.S. publicly-traded firms that experienced exogenous change in the level of shareholder intervention threat due to activist investor closures between 2007 and 2010. The control group includes 206 U.S. publicly-traded firms matched by calendar year, 3-digit SIC industry, total assets, Tobin's Q, and shareholder intervention threat, which did not experience activist investor closures.

the changes in the number of highly-cited patents. In both panels, innovation is averaged across the 206 treatment firms and across the 206 control firms for each year. Year zero is the time of activist investor closures. As shown in both panels, during the four years before the closure events, the treatment and control firms follow a similar path until the onset of activist investor closures. Following activist closures, the innovation of treatment firms increases significantly relative to the control firms. In addition, as shown in Table 2.6, the growth rate of innovation is statistically identical across the treatment and control groups. The magnitudes of the differences (0.002 for total patents and 0.018 for highly-cited patents) are economically small. In sum, the graph of innovation path and the pairwise comparison of innovation growth rate suggest that the treatment firms and the closely matched control firms satisfy the parallel trends assumption required for difference-in-differences estimation.

The effect of activist investor closures on firm innovation is estimated using (14):

$$\ln(Innovation_{i,t}) = \alpha + \beta_1 I_i\,(Activist\,Closures) + \beta_2 I_{i,t}\,(Post) + \beta_3 I_i\,(Activist\,Closures) \times I_{i,t}\,(Post) + \gamma X_{i,t-1} + \nu_k + \mu_t + error_{i,t} \quad (14)$$

Here, subscripts i,t uniquely identify individual observations for firm i in year t. $Innovation_{i,t}$ represents innovation of firm i in year t. $I_i\,(Activist\,Closures)$ is an indicator variable equal to one if one or more of firm i's activist institutional investors closed their operations in the U.S. during 2007-2010. These activist investors hold at least 1% of the firm's outstanding shares. $I_{i,t}\,(Post)$ is an indicator variable equal to one if the observation occurs after the year of activist investor closures. $X_{i,t-1}$ is a vector of control variables. ν_k and μ_t represent industry and year fixed effects. The coefficient of interest is β_3 (the coefficient on the interaction term $I_i\,(Activist\,Closures) \times I_{i,t}\,(Post)$, which is a DiD estimate of the average effect of activist investor closures on firm innovation. Standard errors are clustered at the event (activist investor closure) level to account for the presence of serial correlation (Bertrand, Duflo, and Mullainathan 2004).

The results from estimating (14) are reported in Table 2.7. I examine firm innovation four years before and four years after the event of activist investor closures. In Column (1), the dependent variable is $ln\,(TotalPatents_t)$. The coefficients associated with $I_i\,(Activist\,Closures)\,\times\,I_{i,t}\,(Post)$ are positive and significant at the 5% level. These results suggest that, for an average firm that experiences an exogenous decrease in intervention threat due to activist investor closures, the firm's patent applications increase by 22.8% over the four years after the closure events. In Column (2), the dependent variable is *ln* (*Highly-Cited Patents*$_t$). The estimate of coefficient β_3 is positive and statistically significant at the 1% level. The finding suggests that following activist investor closures, firms produce 25.4% more influential patents relative to control firms. In both columns, the coefficients on $I_i\,(Activist\,Closures)$ are close to zero, implying that there is no significant difference in firm innovation prior to activist investor closures between treatment and control firms.[10] Overall, these results confirm that an exogenous decrease in shareholder intervention threat leads to improved innovation incentives among firm managers.

I conduct a set of robustness tests using alternative matching method and

[10] According to Meyer (1995), a large coefficient on $I_i\,(Activist\,Closures)$ is an indication that standard errors are understated due to the presence of a group effect in the error term. In my current study, the coefficients on $I_i\,(Activist\,Closures)$ are close to zero, suggesting that there is no significant group effect.

Table 2.7: The Effects of Activist Investor Closures on Innovation

This table reports the difference-in-differences estimation on the effects of activist investor closures on firm innovation. Treatment firms are the U.S. publicly-traded firms that experienced exogenous change in the level of shareholder intervention threat due to activist investor closures between 2007 and 2010. Control firms are U.S. publicly-traded firms that were not affected by activist investor closures. Treatment firms and control firms are matched by year, industry (3-digit SIC code), total assets, Tobin's Q, and shareholder intervention threat. I (*Activist Closures*) is an indicator variable equal to one if one or more of the firm's activist institutional investors closed their operations in the U.S. during 2007-2010, and zero otherwise. *I (Post)* is an indicator variable equal to one if the observation occurs after the year of activist investor closures, and zero otherwise. *I (Activist Closure)* $\times$*I (Post)* is an interaction term equal to one if the firm experienced activist investor closures and the observation is after the closure event year, and zero otherwise. Control variables include ln *(Assets), Tobin's Q, ROA, CapExp / Assets, PPE / Assets, Leverage, KZIndex,* ln *(Firm Age), Herfindahl Index, Herfindahl Index squared.* Standard errors are clustered at the event (activist investor closure) level, and are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable	ln (*Total Patents$_t$*)	ln (*Highly-Cited Patents$_t$*)
	(1)	(2)
I (Activist Closure)	-0.027	-0.018
	(0.202)	(0.172)
I (Post)	-0.095	-0.156
	(0.122)	(0.114)
I (Activist Closure) $\times$*I (Post)*	**0.228****	**0.254*****
	(0.081)	(0.068)
Constant	-0.371	-0.160
	(0.304)	(0.295)
Control Variables	Yes	Yes
Year Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Observations	2888	2888
Adjusted R^2	0.405	0.389

alternative selections of matching variables. The robustness test results are reported in Appendix Table A3. First, I use propensity score matching to select control firms. The matching begins with a probit regression of an binary variable that equals one if a firm experienced one or more activist investor closures in a particular year (belongs to the treatment group) on a set of firm characteristics. Specifically, I include activist investor ownership, firm size (logarithm of total assets), Tobin's Q, industry fixed effects, and year fixed effects. The pseudo-R^2 of the probit regression is 0.16 with a p-value well below 0.001, which implies that the specification captures a significant amount of variation in the binary variable. Then I perform a nearest-neighbor match with replacement using the predicted probabilities (propensity scores) from the probit regression. For each treatment firm, I select one control firm that is from the same year and 3-digit SIC industry, and that has the closest propensity score. The DiD estimation results based on propensity score matching are reported in Panel A of Appendix Table A3. The results are qualitatively and quantitatively similar to the baseline DiD estimation (Table 2.7).

The estimation results on the effects of activist investor closures (Table 2.7) are robust to alternative selections of matching variables. As discussed in Section 2.3.2, firm manager's response to intervention threat change is conditional on the extent of shareholder monitoring and analyst following. I include these variables as additional matching variables. Panel B of Appendix Table A3 reports the DiD results. The treatment effects are positive and statistically significant, consistent with the hypothesis that firm innovation significantly improves following activist investor closures. Moreover, a firm's response to intervention threat change may depend on the firm's pre-closure innovation level, which reflects a firm's innovation resources. I include a firm's total number of patent applications, averaged over the three years prior to closure, as an additional matching criterion to the primary matching variables (year, 3-digit SIC industry, total assets, Tobin's Q, and intervention threat level). The results are reported in Panel C of Appendix Table A3.

The estimated treatment effects of activist investor closures remain positive and significant. In addition, I use Hoberg-Phillips industry classification (Hoberg and Phillips, 2010, 2016) to replace the 3-digit SIC industry in the primary matching variables. Hoberg-Phillips industry classification is based on the relatedness of firms in the product market space. Panel D of Appendix Table A3 presents the DiD estimation results. The estimated treatment effects are similar to the baseline DiD results (Table 2.7), although the significance level for the treatment effect on *Total Patents* (Column (1)) declines slightly.

Following Bertrand and Mullainathan (2003), I investigate in greater detail the dynamic effects of activist investor closures on firm innovation (see Table 2.8). The interaction term $I_i\,(Activist\,Closures) \times I_{i,t}\,(Post)$ in equation (14) is replaced with the interaction of $I_i\,(Activist\,Closures)$ with nine time indicators. *Before (-4), Before (-3)*, *Before (-2)*, and *Before (-1)* are the dummy variables that equal one if the firm-year observation is before activist investor closures (4 years before, 3 years before, 2 years before, and 1 year before, respectively), and zero otherwise. *Event Year (0)* is a dummy variable that equals one if the firm-year observation is on the year that activist investor closure events occur, and zero otherwise. *After (+1)*, *After (+2)*, *After (+3)* and *After (+4)* are dummy variables equal to one if the firm-year observation is after activist investor closures (1 year after, 2 years after, 3 years after, and 4 years after, respectively) and zero otherwise.

One reverse causality concern is that activist investor closures may be driven

Table 2.8: Dynamic Analysis of the Effects of Activist Investor Closures

This table reports the estimation results on the dynamic effects of activist investor closures on firm innovation. $I\,(Activist\,Closures)$ is an indicator variable equal to one if one or more of the firm's activist institutional investors closed their funds. *Before (-3)*, *Before (-2)*, and *Before (-1)* are the dummy variables indicating that the firm-year observation is 3 years, 2 years, or 1 year before activist investor closures. *Event Year (0)* is a dummy that equals one if the firm-year observation is on the year in which activist investor closures occur. *After (+1)*, *After (+2)*, *After (+3)* and *After (+4)* are dummy variables indicating that the firm-year observation is 1 year, 2 years, 3 years, or 4 years after activist investor closures. Control variables include ln *(Assets), Tobin's Q, ROA, CapExp / Assets, PPE / Assets, Leverage, KZIndex,* ln *(Firm Age), Herfindahl Index, Herfindahl Index squared.* Year and industry fixed effects are included. Standard errors are clustered at the event (activist investor closure) level, and are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable	ln ($Total\ Patents_t$)	ln ($Highly\text{-}Cited\ Patents_t$)
	(1)	(2)
I (Activist Closure)	-0.018	-0.032
	(0.190)	(0.169)
I (Activist Closure) × *Before (-3)*	0.014	-0.017
	(0.058)	(0.058)
I (Activist Closure) × *Before (-2)*	-0.035	0.032
	(0.069)	(0.061)
I (Activist Closure) × *Before (-1)*	-0.019	0.031
	(0.063)	(0.053)
I (Activist Closure) × *Event Year (0)*	-0.022	0.120
	(0.068)	(0.069)
I (Activist Closure) × *After (+1)*	0.016	0.168**
	(0.077)	(0.058)
I (Activist Closure) × *After (+2)*	0.185***	0.242***
	(0.051)	(0.054)
I (Activist Closure) × *After (+3)*	0.322**	0.392**
	(0.144)	(0.141)
I (Activist Closure) × *After (+4)*	0.498**	0.320**
	(0.204)	(0.112)
Constant	-0.273	-0.114
	(0.296)	(0.301)
Control Variables	Yes	Yes
Year Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Observations	3648	3648
Adjusted R^2	0.421	0.401

by the poor innovation performance of these investors' portfolio firms. If this was indeed the case, then we should observe a significant difference in the innovation trend of treatment and control firms in the years preceding activist investor closures. In fact, the estimated coefficients on the interaction terms $I_i\,(Activist\,Closures) \times$*Before (-3)*, $I_i\,(Activist\,Closures) \times$*Before (-2)*, and $I_i\,(Activist\,Closures) \times$*Before (-1)* are statistically indistinguishable from zero. It shows that the treatment effect cannot be found prior to the closures of activist investors. This implies that innovation performance is unlikely to be the reason that activist investors closed their funds. Significant changes in innovation are observed in the subsequent years following the closure events. The estimated coefficients on $I_i\,(Activist\,Closures) \times$ *After (+2)* are significant at 1% level, and the coefficients on $I_i\,(Activist\,Closures) \times$*After (+3)* and $I_i\,(Activist\,Closures) \times$*After (+4)* are significant at 5% level. Overall, these results provide evidence supporting the causal interpretation of the effects of activist investor closures on firm innovation.

Most of the activist investor closures occurred during the financial crisis period. One potential concern is that the financial crisis differentially affected the treatment firms and control firms, which leads to differential innovation performance. I further investigate whether this was the case. Campello, Graham, and Harvey (2010) suggest that financially constrained firms are affected more by the financial crisis of 2008, and are more likely to bypass attractive investment opportunities. I test whether financial constraints change significantly for treatment firms relative

Table 2.9: Difference-in-Differences Tests for Financial Constraints, Internal Financial Resources, and Short-term Liquidity

This table tests whether treatment and control firms differ in financial constraints, internal financial resources, and short-term liquidity around activist investor closures. Financial constraints is measured using Kaplan-Zingales (1997) index (*KZIndex*). Internal financial resources is proxied by *Cash/Assets*. Short-term Liquidity is measured using *Net Short-term Debt* (short-term debt minus cash). Difference-in-Differences estimator is applied. Standard errors are clustered at the event (activist investor closure) level, and are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Financial Constraints	Internal Financial Resources	Short-term Liquidity
Dependent Variable	*KZIndex*	*Cash/Assets*	*Net Short-term Debt*
	(1)	(2)	(3)
I (Activist Closure)	-9.162	0.027	-0.050
	(6.781)	(0.031)	(0.036)
I (Post)	3.544	0.011	-0.095**
	(9.932)	(0.015)	(0.033)
I (Activist Closure) $\times$*I (Post)*	7.837	-0.001	0.075
	(11.698)	(0.009)	(0.049)
Constant	-9.848**	0.280***	-0.243***
	(4.494)	(0.018)	(0.023)
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	2302	2376	2376
Adjusted R^2	0.150	0.571	0.076

to control firms surrounding activist investor closures. The presence of financial constraints is measured using the Kaplan-Zingales (1997) index (*KZIndex*). Prior to activist investor closures, *KZIndex* is not statistically different between treatment firms and control firms (Table 2.6). To test whether treatment and control firms have differential financial constraints following activist investor closures, I conduct a difference-in-differences test using financial constraints as the dependent variable. In Table 2.9 Column (1) I present the estimation results. The treatment effect is statistically indistinguishable from zero, which implies that financial constraints do not change differentially for treatment group relative to control group.

During the financial crisis, it is plausible that firms may rely more on internal financing. Duchin, Ozbas, and Sensoy (2010) find that internal financial resources mitigate the negative shocks to the supply of external finance during financial crisis, and corporate investment declines less for firms with more cash reserves. I test whether treatment and control firms differ in their cash reserve positions. Duchin, Ozbas, and Sensoy further show that during financial crises, investment declines significantly for firms that lack short-term liquidity (measured by net short-term debt). I also test whether treatment and control firms have differential short-term liquidity around the time of activist investor closures. As shown in Table 2.6, *Cash/Assets* and *Net Short-term Debt* are not statistically different between treatment firms and control firms before activist investor closures. Again, I perform difference-in-differences tests using cash reserve and net short-term debt as dependent variables, and the results are reported in Columns (2) and (3) of Table 2.9. The treatment effects are not statistically significant, implying that treatment and control firms do not have differential cash reserves and short-term liquidity around activist investor closures. The three difference-in-differences estimations reported in Table 2.9 use a seven-year window, with three years before and three years after the activist investor closures. The results are robust to alternative shorter or longer windows. Detailed variable definitions for *KZIndex*, *Cash/Assets* and *Net Short-term Debt* are provided in Appendix Table A1. I conclude that treatment firms and control firms have similar financial constraints, internal financial resources, and short-term liquidity. Thus, it is not likely that the financial crisis has a differential impact on treatment firms relative to control firms. The significant effects of activist investor closures on innovation (as observed in Table 2.7) is not driven by the financial crisis.

2.7. Conclusion

The main finding of this research is that increasing the threat of shareholder intervention has a significant and economically important negative impact on firm innovation. It implies that shifting to a shareholder-centric governance system discourages manager incentives to innovate. Pursuing innovation is often associated with less precise information reflected in stock prices, which increases the likelihood that a good manager with valuable innovation projects will be mistakenly penalized. Thus, firm managers under the threat of shareholder intervention, often refrain from pursuing innovation. Yet, for firms that are more likely to have efficient stock prices, the threat of activist intervention will have less effect on firm innovation. Consistent with this mechanism, I find that the negative effects of intervention threat on innovation are significantly reduced when a firm's shares are held by more monitoring institutional investors and/or the firm is followed by more financial analysts. This research has important policy implications. It suggests that corporate governance reform should consider the impacts of shareholder control on innovation of U.S. publicly-traded firms.

Appendix Table A1: The Effects of Shareholder Intervention Threat on Firm Innovation

This table shows the estimated effects of shareholder intervention threat on firm innovation at the years $t+1$, $t+2$, $t+3$, and $t+4$. Robust standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: OLS Estimation

Dependent Variable	ln (Total Patents$_{t+1}$) (1)	ln (Total Patents$_{t+2}$) (2)	ln (Total Patents$_{t+3}$) (3)	ln (Total Patents$_{t+4}$) (4)	ln (Highly-Cited Patents$_{t+1}$) (5)	ln (Highly-Cited Patents$_{t+2}$) (6)	ln (Highly-Cited Patents$_{t+3}$) (7)	ln (Highly-Cited Patents$_{t+4}$) (8)
Intervention Threat	-0.940***	-0.962***	-0.844***	-0.699**	-0.780***	-0.823***	-0.757***	-0.682**
	(0.298)	(0.311)	(0.326)	(0.345)	(0.271)	(0.276)	(0.282)	(0.294)
ln *(Assets)*	0.281***	0.289***	0.295***	0.295***	0.217***	0.220***	0.220***	0.211***
	(0.018)	(0.018)	(0.020)	(0.021)	(0.015)	(0.016)	(0.017)	(0.017)
Tobin's Q	0.002	0.005	0.005	0.001	0.002	0.005	0.005	0.001
	(0.004)	(0.005)	(0.005)	(0.005)	(0.003)	(0.004)	(0.004)	(0.004)
ROA	-0.097	-0.075	-0.101	-0.121*	-0.058	-0.053	-0.072	-0.075
	(0.059)	(0.063)	(0.068)	(0.072)	(0.052)	(0.054)	(0.058)	(0.060)
CapExp / Assets	1.818***	2.177***	2.473***	2.588***	1.476***	1.838***	2.110***	1.860***
	(0.356)	(0.381)	(0.410)	(0.431)	(0.317)	(0.332)	(0.347)	(0.362)
PPE / Assets	-0.363**	-0.431***	-0.454***	-0.490***	-0.243*	-0.315**	-0.345**	-0.304**
	(0.147)	(0.153)	(0.161)	(0.170)	(0.128)	(0.131)	(0.136)	(0.139)
Leverage	-0.259***	-0.250***	-0.260***	-0.256***	-0.219***	-0.210***	-0.207***	-0.200***
	(0.044)	(0.048)	(0.052)	(0.056)	(0.038)	(0.042)	(0.045)	(0.048)
KZIndex	-0.000	-0.000	-0.000	0.000	-0.000	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln *(Firm Age)*	-0.138***	-0.133***	-0.134***	-0.138***	-0.111***	-0.104***	-0.104***	-0.106***
	(0.031)	(0.032)	(0.035)	(0.037)	(0.028)	(0.029)	(0.030)	(0.032)
Herfindahl Index	-0.514	-0.569	-0.645	-0.720	-0.495	-0.490	-0.436	-0.477
	(0.363)	(0.387)	(0.421)	(0.459)	(0.326)	(0.344)	(0.366)	(0.391)
Herfindahl Index^2	0.163	0.181	0.237	0.360	0.227	0.214	0.179	0.289
	(0.410)	(0.438)	(0.480)	(0.528)	(0.364)	(0.385)	(0.413)	(0.447)
Constant	-0.340**	-0.277*	-0.346**	-0.311*	-0.344***	-0.346***	-0.387***	-0.420***
	(0.134)	(0.142)	(0.152)	(0.164)	(0.119)	(0.126)	(0.133)	(0.141)
Year FE, Industry FE, Frim FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14175	13414	12652	11908	14175	13414	12652	11908
Adjusted R^2	0.648	0.639	0.625	0.600	0.637	0.622	0.603	0.572

Appendix Table A1 (Continued)

Panel B: Negative Binomial Estimation

Dependent Variable	*Total* $Patents_{t+1}$ (1)	*Total* $Patents_{t+2}$ (2)	*Total* $Patents_{t+3}$ (3)	*Total* $Patents_{t+4}$ (4)	*Highly-Cited* $Patents_{t+1}$ (5)	*Highly-Cited* $Patents_{t+2}$ (6)	*Highly-Cited* $Patents_{t+3}$ (7)	*Highly-Cited* $Patents_{t+4}$ (8)
Intervention Threat	-1.128***	-1.239***	-1.160***	-1.137***	-0.735*	-0.921**	-0.958*	-0.929
	(0.403)	(0.423)	(0.430)	(0.438)	(0.427)	(0.467)	(0.503)	(0.576)
ln *(Assets)*	0.489***	0.500***	0.500***	0.490***	0.454***	0.457***	0.455***	0.434***
	(0.024)	(0.025)	(0.027)	(0.028)	(0.024)	(0.026)	(0.028)	(0.030)
Tobin's Q	0.004	0.008	0.011	0.001	0.004	0.012	0.013*	0.003
	(0.008)	(0.008)	(0.008)	(0.006)	(0.006)	(0.008)	(0.007)	(0.007)
ROA	-0.298***	-0.299***	-0.317***	-0.378***	-0.227**	-0.225**	-0.255**	-0.290**
	(0.089)	(0.097)	(0.101)	(0.107)	(0.102)	(0.109)	(0.113)	(0.120)
CapExp / Assets	3.086***	3.403***	4.122***	3.925***	3.293***	3.611***	4.106***	3.734***
	(0.554)	(0.581)	(0.633)	(0.679)	(0.603)	(0.644)	(0.703)	(0.767)
PPE / Assets	-0.808***	-0.890***	-1.003***	-1.111***	-0.751***	-0.870***	-0.946***	-0.995***
	(0.210)	(0.224)	(0.239)	(0.259)	(0.227)	(0.246)	(0.263)	(0.287)
Leverage	-0.295***	-0.270***	-0.258***	-0.299***	-0.315***	-0.289***	-0.280***	-0.281***
	(0.061)	(0.070)	(0.072)	(0.074)	(0.070)	(0.079)	(0.081)	(0.089)
KZIndex	0.000	0.001	-0.000	0.001*	-0.000	0.000	-0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ln *(Firm Age)*	-0.241***	-0.226***	-0.229***	-0.230***	-0.254***	-0.236***	-0.237***	-0.244***
	(0.041)	(0.043)	(0.045)	(0.047)	(0.045)	(0.047)	(0.049)	(0.051)
Herfindahl Index	-0.431	-0.601	-0.789	-1.041*	-0.482	-0.551	-0.517	-0.811
	(0.518)	(0.550)	(0.586)	(0.627)	(0.566)	(0.594)	(0.627)	(0.685)
Herfindahl Index^2	-0.299	-0.195	0.087	0.443	-0.241	-0.238	-0.196	0.222
	(0.584)	(0.622)	(0.657)	(0.689)	(0.623)	(0.659)	(0.699)	(0.761)
Constant	-2.147***	-1.998***	-1.836***	-1.519***	-2.483***	-2.308***	-2.152***	-1.837***
	(0.556)	(0.555)	(0.556)	(0.557)	(0.556)	(0.562)	(0.551)	(0.572)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14175	13414	12652	11908	14175	13414	12652	11908

Appendix Table A2: Shareholder Intervention Threat and Innovation, Robustness Check

This table reports the robustness check on the effects of shareholder intervention threat on firm innovation using alternative measures of intervention threat. In Panel A, the main explanatory variable *Intervention Threat* is measured based on the ownership of the activist institutional investors who own more than 1% of firm outstanding shares. In Panel B, *Intervention Threat* is measured based on the ownership of the activist institutional investors who own more than 5% of firm outstanding shares. Firm fixed effects are controlled using the "presample mean scaling" method, following the procedure in Blundell, Griffith, and Van Reenen (1999). Robust standard errors clustered by firm are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Activist Institutional Investors with More than 1% Ownership

Model	OLS	OLS	Negative Binomial	Negative Binomial
Dependent Variable	ln (*Total Patents*$_{t+2}$)	ln (*Highly-Cited Patents*$_{t+2}$)	*Total Patents*$_{t+2}$	*Highly-Cited Patents*$_{t+2}$
	(1)	(2)	(3)	(4)
Intervention Threat	-0.993***	-0.829***	-1.245***	-0.939**
	(0.310)	(0.275)	(0.421)	(0.466)
ln *(Assets)*	0.288***	0.219***	0.499***	0.457***
	(0.018)	(0.016)	(0.025)	(0.026)
Industry Q	0.004	0.005	0.007	0.012
	(0.004)	(0.004)	(0.008)	(0.008)
ROA	-0.075	-0.053	-0.301***	-0.227**
	(0.063)	(0.054)	(0.097)	(0.109)
CapExp / Assets	2.171***	1.834***	3.394***	3.604***
	(0.381)	(0.332)	(0.581)	(0.644)
PPE / Assets	-0.429***	-0.313**	-0.885***	-0.868***
	(0.153)	(0.131)	(0.224)	(0.246)
Leverage	-0.249***	-0.210***	-0.270***	-0.289***
	(0.048)	(0.042)	(0.070)	(0.079)
KZIndex	-0.000	-0.000	0.001	0.000
	(0.000)	(0.000)	(0.001)	(0.001)
ln *(Firm Age)*	-0.133***	-0.105***	-0.226***	-0.236***
	(0.032)	(0.029)	(0.043)	(0.047)
Herfindahl Index	-0.569	-0.490	-0.599	-0.548
	(0.387)	(0.344)	(0.550)	(0.595)
Herfindahl Index ^{2}	0.180	0.213	-0.199	-0.241
	(0.438)	(0.385)	(0.623)	(0.660)
Constant	-0.279*	-0.349***	-1.994***	-2.307***
	(0.142)	(0.127)	(0.555)	(0.562)
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	13414	13414	13414	13414

Appendix Table A2 (Continued)

Panel B: Activist Institutional Investors with More than 5% Ownership

Model	OLS	OLS	Negative Binomial	Negative Binomial
Dependent Variable	ln (*Total Patents*$_{t+2}$)	ln (*Highly-Cited Patents*$_{t+2}$)	*Total Patents*$_{t+2}$	*Highly-Cited Patents*$_{t+2}$
	(1)	(2)	(3)	(4)
Intervention Threat	-0.987***	-0.851***	-1.329***	-1.142**
	(0.332)	(0.293)	(0.439)	(0.481)
ln *(Assets)*	0.286***	0.217***	0.497***	0.456***
	(0.018)	(0.016)	(0.025)	(0.026)
Industry Q	0.005	0.005	0.008	0.012
	(0.004)	(0.004)	(0.008)	(0.009)
ROA	-0.077	-0.054	-0.305***	-0.230**
	(0.063)	(0.054)	(0.097)	(0.109)
CapExp / Assets	2.168***	1.830***	3.398***	3.602***
	(0.381)	(0.333)	(0.584)	(0.646)
PPE / Assets	-0.424***	-0.309**	-0.878***	-0.863***
	(0.153)	(0.131)	(0.225)	(0.247)
Leverage	-0.250***	-0.211***	-0.271***	-0.289***
	(0.048)	(0.042)	(0.070)	(0.079)
KZIndex	-0.000	-0.000	0.001	0.000
	(0.000)	(0.000)	(0.001)	(0.001)
ln *(Firm Age)*	-0.134***	-0.105***	-0.227***	-0.237***
	(0.032)	(0.029)	(0.043)	(0.047)
Herfindahl Index	-0.567	-0.489	-0.596	-0.549
	(0.388)	(0.345)	(0.551)	(0.596)
Herfindahl Index ^{2}	0.181	0.214	-0.199	-0.240
	(0.439)	(0.386)	(0.624)	(0.662)
Constant	-0.294**	-0.360***	-1.994***	-2.307***
	(0.143)	(0.127)	(0.553)	(0.560)
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	13414	13414	13414	13414

Appendix Table A3: The Effects of Activist Investor Closures on Innovation, Robustness Check

This table reports the robustness check on the estimated effects of activist investor closures on firm innovation (Table 5). Panel A presents the results using propensity score matching. Panels B, C, and D report the results using alternative matching variables. In Panel B, treatment firms and control firms are matched by year, industry (3-digit SIC), total assets, Tobin's Q, intervention threat level, shareholder monitoring, and financial analysts. In Panel C, treatment firms and control firms are matched by year, industry (3-digit SIC), total assets, Tobin's Q, intervention threat level, and pre-closure innovation level. In Panel D, treatment firms and control firms are matched by year, industry, total assets, Tobin's Q, and intervention threat level. Hoberg-Phillips industry classification is used to replace 3-digit SIC industry. Standard errors are clustered at the event (activist investor closure) level, and are displayed in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Difference-in-Differences Estimation, Propensity Score Matching

Dependent Variable	ln ($Total\ Patents_t$)	ln ($Highly\text{-}Cited\ Patents_t$)
	(1)	(2)
I (Activist Closure)	-0.218	-0.140
	(0.132)	(0.113)
I $(Post)_t$	0.064	-0.033
	(0.056)	(0.062)
I (Activist Closure) $\times$ *I* $(Post)_t$	0.198**	0.278***
	(0.070)	(0.074)
Constant	-0.788*	-0.586*
	(0.375)	(0.317)
Control Variables	Yes	Yes
Year Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Observations	2827	2827
Adjusted R^2	0.470	0.440

Panel B: Difference-in-Differences Estimation, Using Shareholder Monitoring and Analyst Following as Additional Matching Variables

Dependent Variable	ln ($Total\ Patents_t$)	ln ($Highly\text{-}Cited\ Patents_t$)
	(1)	(2)
I (Activist Closure)	-0.195	-0.111
	(0.213)	(0.174)
I $(Post)_t$	-0.333***	-0.368***
	(0.079)	0.081)
I (Activist Closure) $\times$ *I* $(Post)_t$	0.267**	0.425***
	(0.116)	(0.121)
Constant	-0.280	-1.191**
	(0.426)	(0.372)
Control Variables	Yes	Yes
Year Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Observations	2891	2891
Adjusted R^2	0.417	0.382

Appendix Table A3 (Continued)

Panel C: Difference-in-Differences Estimation, Using Pre-Closure Innovation Level as Additional Matching Variable

Dependent Variable	ln (*Total Patents*$_t$)	ln (*Highly-Cited Patents*$_t$)
	(1)	(2)
I (Activist Closure)	-0.039	0.055
	(0.080)	(0.074)
I (Post)$_t$	-0.164	-0.158
	(0.139)	(0.139)
I (Activist Closure) $\times$*I (Post)*$_t$	0.315**	0.290***
	(0.113)	(0.084)
Constant	-0.093	-0.768*
	(0.423)	(0.367)
Control Variables	Yes	Yes
Year Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Observations	2883	2883
Adjusted R^2	0.418	0.392

Panel D: Difference-in-Differences Estimation, Matching Based on Hoberg-Phillips Industry Classification

Dependent Variable	ln (*Total Patents*$_t$)	ln (*Highly-Cited Patents*$_t$)
	(1)	(2)
I (Activist Closure)	-0.128	-0.025
	(0.193)	(0.186)
I (Post)$_t$	-0.070	-0.119***
	(0.129)	(0.120)
I (Activist Closure) $\times$*I (Post)*$_t$	0.182*	0.254***
	(0.092)	(0.074)
Constant	-0.606**	-0.563**
	(0.245)	(0.213)
Control Variables	Yes	Yes
Year Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Observations	2757	2757
Adjusted R^2	0.423	0.417

Chapter 3

Derivative Litigation and Board Effectiveness: Evidence from Delaware's Judicially-led Reforms in 2003

3.1. Introduction

In the post-Enron era, the boards of directors of publicly-traded companies face greater scrutiny, and an increased possibility of being challenged in a courtroom. At the federal level, the Sarbanes-Oxley Act of 2002 increases the oversight duties of boards of directors. At the state level, tougher judicial opinions from the Delaware courts have heightened the standards for evaluating director conduct. These initiatives have limited the traditional protections for directors. With the heightened scrutiny, directors may find it more difficult to dismiss derivative lawsuits challenging their actions. An important question is: How does this shift in the legal environment and the increased litigation threat for directors, affect board of director behavior? This question is important because boards of directors play a central role in corporate governance, and examining their responses to legal and judicial reforms can help scholars, regulators, and practitioners evaluate the effectiveness of various legislative and regulatory initiatives to improve corporate governance practices.

In this research, I focus on Delaware court judicial decisions related to corporate governance litigation.[11] Delaware plays a prominent role in corporate law, as more than 50% of publicly-traded companies in the United States, and over 60% of the Fortune 500 companies, are incorporated in the State of Delaware. In 2003, the Delaware Chancery Court and the Delaware Supreme Court adjusted their corporate law jurisprudence, conferring less judicial deference to director business judgment. The courts lowered their procedural hurdles to derivative litigation, allowing more shareholder derivative lawsuits to survive pretrial motions to dismiss.

Shareholder litigation can take the form of derivative suits and direct suits. A derivative lawsuit is an action brought by a corporate shareholder on behalf of the corporation to enforce a corporate right that the officers and directors of the corporation have failed to enforce. The lawsuit is "derivative" because only the corporation has the right to sue its directors and officers, and shareholders may sue these parties on behalf of the corporation only if the corporation refuses to redress the harm on the corporation. Direct lawsuit, which is either individual or class-action, is brought by shareholders in their own right, to redress harms inflicted on the particular shareholders. The financial incentives and procedural mechanisms differ for the two types of lawsuit (Clark, 1986). Ferris *et al.* (2007) commented that derivative lawsuits are better suited than class action lawsuits to

[11] Clark (2005) states that in the wake of the Sarbanes-Oxley Act, corporate governance in the American public corporations were affected by "four sources of policy change — the Sarbanes-Oxley Act, new listing requirements, governance rating agencies, and tougher judicial opinions (notably in Delaware) about perennial corporate governance issues (p.251)."

examine how shareholder litigation rights affect corporate governance. In derivative litigation, plaintiff shareholders act in the interests of all shareholders, and thus are more likely to address agency problems that exist between shareholders and management.

A major procedural hurdle to derivative litigation is the demand requirement that stockholders make a pre-suit demand to the board to initiate the suit, or alternatively demonstrate with "particularized facts" that the demand would be a futile gesture. Since 2003, Delaware courts have liberalized Section 220 of the Delaware General Corporation Law (DGCL), which permits shareholders to inspect corporate books and records. The courts encouraged shareholders to use Section 220 rights to obtain "particularized facts" for pleading demand futility.

Another major procedural hurdle to derivative litigation is the special litigation committee (SLC), made up of the board's independent directors. The SLC makes pretrial investigation of the lawsuit and determines whether continuing the litigation is in the best interest of the corporation. The Delaware courts imposed more restrictive standards of SLC independence, and gave less deference to SLC's recommendation of dismissal of the suit. Lowering these procedural hurdles empowered shareholders to seek derivative litigation against corporate directors.

Since 2003, Delaware's courts have permitted many more derivative lawsuits to proceed. In *In re Walt Disney Co. Derivative Litigation*, the court challenged the business judgment of directors in a duty of care case. In *In re Oracle Corp.*

Derivative Litigation, the court refused to defer to the recommendation of a special litigation committee (SLC). These cases would have been dismissed prior to the 2001-2002 scandals. Frieswick commented that "the court's willingness to hear them may encourage disgruntled shareholders of other companies to test the protections of the business-judgment rule" (*CFO Magazine*, February 19, 2004).

Jones (2004) states that the main reason for the jurisprudential shift in Delaware is the threat of federal preemption. After the Sarbanes-Oxley Act in 2002, the Delaware judiciary was mindful of Congress's preemptive power, and the possibility that uniform federal standards could erode Delaware's appeal as a legal home for business entities, which may lead to significant loss of franchise tax revenue. In response, Delaware courts took the initiative to reform its state's corporate law, increasing scrutiny of director liability for the breach of fiduciary duty, to forestall further federal preemption.

Delaware's judicially-led reforms in 2003 provide a valuable opportunity for researchers to examine the effects of derivative litigation on corporate governance. In the United States, corporate law in all states grants shareholders the right to vote, sell, and sue (Thompson, 1999). Corresponding to these rights, shareholders can potentially exert governance through three main mechanisms. The first is shareholder intervention (also known as "voice"), which includes electing corporate directors, voting against mergers, proxy fights, etc. The second main avenue for shareholders to exert governance is disciplinary trading (also known as "exit" or "Wall Street Walk"), where shareholders sell a company's shares, pushing down the stock price. The third main governance mechanism is shareholder litigation. While most research on shareholder governance has focused on intervention and disciplinary trading, the corporate governance effect of shareholder litigation has been largely ignored in the literature. The traditional view on shareholder litigation is that the role of shareholder litigation in corporate governance is limited, because the business judgment rule effectively shields corporate directors and officers from exposure to liability. Delaware courts' judicial decisions in 2003 departed dramatically from the traditions of director and management deference that preceded Enron (Jones, 2004). The jurisprudential change empowered shareholders to pursue derivative litigation. Thus, shareholder litigation becomes an important arena for shareholders to exert influence over corporate governance.

I exploit the jurisprudential shift in Delaware to test the effects of derivative litigation on corporate governance. The judicially-led reforms in Delaware generate an exogenous change in the threat of derivative litigation facing Delaware corporations. I examine the effectiveness of boards of directors in monitoring the chief executive officers (CEO) in publicly-traded firms around the 2003 reforms. Using a difference-in-differences method, I compare firms incorporated in Delaware with those incorporated in other states from the pre-reform period (2000-2002) to the post-reform period (2003-2005). I find that empowering shareholders to pursue derivative actions largely improves board effectiveness. Specifically, boards of directors make more effective decisions on CEO compensation and replacement. The empirical results show that following the Delaware's judicially-led reforms, Delaware corporations exhibit higher CEO pay-for-performance sensitivity than non-Delaware firms. The results imply that the threat of derivative litigation incentivizes directors to monitor CEO pay and design compensation contracts that motivate top management to create shareholder value. In addition, I find that subsequent to the Delaware reforms, Delaware firms show greater sensitivity of CEO turnover to firm performance. This result suggests that derivative litigation motivates directors to align with shareholders and enforce discipline on poorly-performing management. Overall, my findings provide evidence that derivative litigation has economically important effects on corporate governance practice. Shareholder litigation can serve as an effective mechanism for shareholders to exert governance.

This study is related to two recent papers on the effects of derivative litigation on corporate governance. Ferris *et al.* (2007) examine the change in board characteristics surrounding the filings of derivative lawsuits. They find that following derivative litigation, the proportion of outside directors increases, board size decreases, and fewer CEOs continue to hold the position of board chairman. These board characteristics are associated with good corporate governance in literature. Appel (2015) examines the staggered adoption of universal demand law in 23 states between 1989 and 2005. The universal demand (UD) law requires shareholders to make demand in every derivative lawsuit, thus imposing a significant obstacle to derivative litigation. He finds that the adoption of universal demand law leads to increased use of governance provisions that increase management entrenchment and limit shareholder voice. My research is based on the Delaware's judicially-led reforms in 2003, which empowered shareholders to exert governance through their litigation rights. I document that following the reforms, boards of directors are more effective in monitoring CEOs. In general, my study, along with those two papers, supports the view that derivative litigation is an important corporate governance mechanism.

This paper also differs from Appel (2015) in two aspects. First, Appel (2015) is focused on the agency conflicts between shareholders and managers, and his empirical analysis shows that weakening shareholder litigation rights leads to an increase in management entrenchment, and impaired firm performance. My research examines how shareholder litigation rights affect the incentives and effectiveness of boards of directors to perform governance functions. I find that empowering shareholders to pursue derivative litigation leads to improved board incentives to monitor CEO and more effective decisions on CEO compensation and replacement. Second, Appel (2015) relies on the adoption of universal demand (UD) laws to identify the effects of derivative litigation on corporate governance. This research design is very innovative, but it has limitations. The influence of the UD laws may be limited, as the laws only affected the states that not many companies are incorporated. The majority of the publicly-traded companies in the United States are incorporate in the states of Delaware or New York, where the UD laws were not adopted. My paper replies on Delaware's judicially-led reforms as an exogenous shock to shareholder power to pursue derivative litigation. Given Delaware's prominent role in American corporate law, the judicially-led reforms in 2003 had a far-reaching impact on shareholder litigation rights. As more than 50% of publicly-traded companies in the United States are incorporated in the State of Delaware, the reforms in Delaware corporate law generate sufficient variation in litigation rights among U.S. companies. The empirical results based on this design provide important evidence on the effects of shareholder litigation rights on corporate governance.

The remainder of this chapter is organized as follows. In section 3.2, I review Delaware's judicially-led reforms in 2003. In section 3.3, I formulate my hypotheses on the effects of derivative litigation on board effectiveness. I describe data and variable measurement in section 3.4, and employ difference-in-differences method to test the governance effects of derivative litigation in section 3.5. I conclude the chapter in section 3.6.

3.2. Institutional Background on Delaware's Judicially-led Reforms in 2003

The 2001-2002 corporate scandals, typified by Enron and WorldCom, evoked broad public criticism of the existing corporate regulatory regime. Scholars and business lawyers challenged that the state courts had always granted judicial deference to corporate directors and officers, and provided few effective means for shareholders to redress corporate wrongdoing. The need for legal reform became glaringly apparent. The federal government enacted the Sarbanes-Oxley Act in 2002, which has been generally considered as the most far reaching reform of American business practices since the Securities Act of 1933.

Delaware is at the center of corporate law in America. Delaware's courts, in response to the widespread corporate scandals and the Sarbanes-Oxley Act, adjusted its corporate law jurisprudence, moving to a more restrictive application of the business judgment rule and more vigorous enforcement of officers' and directors' fiduciary duties (Jones, 2004). In this section, I review the details of Delaware's judicially-led reforms in 2003.

Before the Enron and WorldCom scandals, Delaware built a reputation as the most management-friendly state.[12] Delaware's courts had reinforced substantive limitations on director liability by imposing procedural barriers to litigation against them. The two most significant procedural hurdles that shareholder plaintiffs face are the demand requirement and the special litigation committee (SLC) device. Prior to instituting a derivative action, shareholder plaintiffs must make a demand on the corporation's directors to enforce a corporate right (e.g. sue the

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[12] Jones (2004) comments that "Before Enron, Delaware was the state where managers turned for assurances of minimal exposure to personal liability for mistakes, misjudgments, wrongdoing, or self-dealing."

directors or executive officers for breach of fiduciary duties). Once the demand is rejected by directors, the burden is on the plaintiff shareholders to show that the Board wrongfully refused the plaintiff's pre-suit demand. The courts generally review the Board's decision under the deferential business judgment rule and rarely second guess the Board's decision. Alternatively, plaintiff shareholders can demonstrate that the directors are incapable of making an impartial decision regarding the litigation, so the demand is futile and would be excused.

In Delaware, Court of Chancery Rule 23.1 requires that allegations of demand futility must comply with stringent requirements of "factual particularity". Under the *Aronson* test, a demand is excused if the alleged particularized facts create a reasonable doubt that: (1) the directors are disinterested and independent, and (2) the challenged transaction was otherwise the product of a valid exercise of business judgment. If either condition is satisfied, demand is excused and the case may proceed. A common complaint from plaintiff shareholders is that the system of requiring a shareholder plaintiff to plead particularized facts for establishing demand futility is basically unfair because Delaware's courts do not permit discovery. Even if the plaintiff shareholders succeed in showing that demand should be excused as futile, directors have an additional opportunity to avoid litigation. They can appoint a special litigation committee (SLC), made up of independent and disinterested directors, to consider whether the corporation should proceed with litigation. The committee almost always concluded that continuing the suit was against the corporation's interest and recommended dismissal of the lawsuit. Delaware's courts typically deferred to the business judgment of the SLC. Overall, the demand requirement and the SLC made it virtually impossible for shareholders to challenge directors' decision making through derivative litigation.

This situation changed dramatically in 2003. The Delaware Supreme Court made "pro-shareholder moves" (Subramanian, 2003) and lowered the procedural hurdles to derivative litigation. The Court, through their judicial opinions, encouraged shareholder plaintiffs to pursue a Section 220 action to uncover the facts that would allow them to establish demand futility. Section 220 of the Delaware General Corporation Law (DGCL) permits stockholders to inspect corporate books and records for any "proper purpose" and provides for enforcement of that right by the Court of Chancery. To facilitate shareholder plaintiff's discovery of particular facts, Delaware amended Section 220 of the DGCL in 2003. The amendment extends the right of inspection from record owners to beneficial owners[13] of a corporation's stock, and permits inspection of the books and records of subsidiaries, including non-Delaware subsidiaries, of Delaware corporations. Radin (2006) commented that the Section 220 of DGCL marks a new stage of corporate governance litigation.

In 2003 and afterward, Delaware's courts have made a series of judicial deci-

[13] A record owner or registered owner holds shares directly with the company. A beneficial owner holds shares indirectly, through a bank or broker-dealer. The majority of U.S investors own their securities as beneficial owners.

sions that imposed stricter judicial standards for evaluating director conduct. The Delaware Court of Chancery's 2003 decision in *In re Walt Disney Co. Derivative Litigation*[14] is one of the most important decisions. The initial Disney lawsuit was filed in 1998 and alleged a general breach of duty on the part of the directors. The Delaware Court of Chancery dismissed all of the shareholder plaintiffs' claims. The court stated that plaintiffs failed to satisfy the demand requirement, because the case was not supported by particularized facts or meaningful discovery. In 2003, the shareholder plaintiffs repleaded demand futility using Section 220 action to obtain sufficient facts about the actions of the Disney board. The shareholder established that the Board of Directors failed to oversee the hiring of Michael Ovitz as president of Disney in October 1995. Michael Eisner, the CEO of Disney, unilaterally hired his close friend Michael Ovitz. The Board of Directors and the Compensation Committee approved the hiring in less than an hour on the same day it was first presented. Both committees saw only a rough, incomplete summary of the employment agreement, received no expert advice on the agreement, and approved it without seeing a final version. The Board of Directors, which met immediately after the Compensation Committee, asked no questions about salary or termination terms. Instead, the board delegated authority to Ovitz and Eisner to work out the terms of the agreement, which were generous. The Delaware Chancery Court concluded that the alleged facts created a reasonable doubt as to whether the directors acted honestly and in good faith, and the Court refused to

[14]See I*n re* Walt Disney Co. Derivative Litig., 825 A.2d 275 (Del. Ch. 2003)

dismiss the plaintiff's claims against the Disney directors. The judicial decisions on the Disney case in 2003 depart sharply from the rulings in 1998.

The second case that exemplifies the trend toward stricter judicial standards is *In re Oracle Corp. Derivative Litigation*.[15] This case was decided by the Delaware Court of Chancery in June 2003. In March 2001, Oracle announced significantly lower-than-expected earnings and license revenue growth. As a result, the Oracle stock price dropped dramatically. Two months earlier, four Oracle directors sold a considerable amount of their Oracle common stock. The shareholders sued the four Oracle directors, including its Chairman and CEO Larry Ellison, for breaching their duty of loyalty by engaging in insider trading. The defendant directors then formed a special litigation committee (SLC), made up of two independent directors, to investigate the derivative suit. The SLC produced a 1,100-page report, concluding that the defendants did not have material nonpublic information before they traded their shares, and recommending termination of the derivative suit.

The Court of Chancery dissected the social and professional connections between SLC members and the defendant directors. Two SLC members, Joseph Grundfest and Hector Molina-Garcia, were Stanford University professors and alumni. The defendant directors include Michael Boskin, who was a former economics professor at Stanford, and William Lucas, who had contributed almost $16 million to Stanford. In addition, the CEO Larry Ellison has made more than

[15] See *In re* Oracle Corp. Derivative Litig., 824 A.2d 917 (Del. Ch. 2003).

$10 million in donations to Stanford in the past and was in current negotiations with Stanford about a potential $170 million donation. The Court of Chancery concluded that the SLC was not sufficiently independent to evaluate the plaintiffs' claim, and refused to defer to the SLC's recommendation. The Oracle case survived the motion to dismiss. This ruling departs from previous Delaware decisions, which had focused on material economic relationships and would not have questioned the SLC's independence based on "personal and other relationships" between defendant directors and SLC members. Therefore, the Oracle decision indicates that the Delaware courts increased their standards for SLC independence, and heightened its scrutiny on the application of the business judgment rule.

The foregoing analysis demonstrates that the Delaware judiciary took the initiative to reform its state's corporate law and imposed stricter judicial standards for evaluating director conduct in 2003. As *The Economist* commented, "Reacting to the latest anti-business sentiment in Washington, DC, Delaware's judges appear ready to adopt a more hawkish line on the duty of directors to represent shareholders' interests (October 25, 2003)." This jurisprudential shift in 2003 indicates that the shareholders of Delaware corporations are more able to pursue derivative action to affect corporate governance.[16]

[16] Jones (2004) states that Delaware's judicially-led reforms in 2003 is a response to the preemptive threat of federal legislature. As the federal preemptive threat recedes over time, Delaware judiciary can relax its restrictive standards of director conduct. The Chancery Court's 2005 decisions in *In re Walt Disney Co. Derivative Litigation* exonerated all of the Disney defendants from liability. In the Oracle case, the court ultimately favored the defendants.

3.3. Hypothesis Development

Shareholders may use their litigation rights to exert influence over corporate governance. To what extent can shareholders rely on derivative litigation to improve corporate governance? Prior literature points to the limitations of derivative litigation as a governance mechanism. First, all states allow corporations to purchase directors' and officers' liability insurance (D&O insurance), which provides them with protections against legal liability. Romano (1991) shows that most shareholder lawsuits are settled, in which D&O insurers pay the settlement and a firm's rising insurance premium is borne by all of the shareholders. Lin, Officer, and Zou (2011) demonstrate that D&O insurance reduces the incentive of directors and managers to act in the best interest of shareholders in mergers and acquisitions, as the D&O insurance insulates them from shareholder litigation and financial liability. These research findings imply that the prevailing D&O insurance has restricted the disciplinary role of shareholder litigation.

Second, shareholders who pursue derivative litigation face a variety of procedural and substantive restrictions. As discussed in Section 2, the demand requirement and the device of special litigation committee make it virtually impossible for shareholders to pursue derivative litigation. In fact, in 1990s only a small number of cases survived pretrial motions to dismiss.

Third, the function of derivative litigation as a governance device is hampered by collective action problem (Romano, 1991). Financial recoveries from derivative lawsuits usually go to the corporation. For individual shareholders, the pro rata benefit from pursuing derivative litigation may not be enough to cover the cost of bringing the lawsuit. These potential problems with derivative litigation lead economics and law scholars to conclude that derivative litigation is an ineffective instrument of corporate governance (Thompson and Thomas, 2004; Becht, Bolton, and Röell 2003).

Delaware's judicially-led reforms in 2003 have dramatically changed firm's litigation environment. This shift in Delaware jurisprudence provides an opportunity for researchers to reexamine the effects of derivative litigation on corporate governance. The Board of Directors is central to corporate governance. I examine how the threat of derivative litigation affects the effectiveness of the Board of Directors in performing its monitoring function. In particular, I evaluate whether the Board sets up CEO compensation schemes that motivate the CEO to create shareholder value. In addition, I examine whether the Board makes timely CEO replacement decisions when firm stock returns decline.

The theoretical literature on corporate governance shows that building effective boards requires aligning the interests of directors with those of shareholders (Warther, 1998; Hirshleifer and Thakor, 1994). This alignment between the Board and shareholders can be achieved through setting director compensation and through exploiting the reputational concerns of the directors (John and Senbet, 1998). Since the D&O insurance insulates directors from financial liability, director's motivation to effectively monitor top management in the derivative litigation context may come from their reputational concerns. Adams, Hermalin, and Weisbach (2010) state that directors' reputation is particularly important in the market for directorships, and reputation concerns largely affect director actions. Fama and Jensen (1983) show that directors have incentives to develop reputations as decision experts, and their reputation concern motivates them to be effective monitors. Shareholder litigation can severely damage directors' reputation and career opportunities. For example, Fich and Shivdasani (2007) document that directors experience a significant decline in the number of board seats they hold in other companies following financial fraud lawsuits. Similarly, Brochet and Srinivasan (2014) show that when a director is subject to securities class-action lawsuits, the director receives more negative recommendations from Institutional Shareholder Services, a proxy advisor firm, and is more likely to lose his/her seat in director elections. When Delaware's judicially-led reforms increase the threat of derivative litigation, reputation concerns may motivate directors to take more effort to fulfill their monitoring duties.

Moreover, the literature on director incentives recognizes a potential reputational trade-off. Although shareholders elect directors, firm management has important influence over the director-nominating process. CEOs who are looking to acquire power often favor directors who are unlikely to rock the boat. Thus, directors who gain reputation for monitoring and replacing a firm's CEO may receive less nominations at other companies where the CEO has strong control. Levit and Malenko (2016) show that whether a director is willing to develop a shareholder-friendly or management-friendly reputation depends on the aggregate quality of corporate governance. If more firms in an economy exhibit strong shareholder control, a shareholder-friendly reputation will be rewarded more in the directorial labor market. As a result, directors will have more incentives to build a reputation for being shareholder-friendly. Delaware's judicial reforms in 2003 uphold shareholder litigation rights and enhance shareholder power in corporate governance. As shareholder power increases relative to that of management in Delaware corporations, shareholder-friendly reputation would be more valuable for directors. This would motivate directors to develop a reputation of shareholder-friendliness by performing the function of monitoring and disciplining management.

Based on the analysis of director's reputational concerns, I propose that higher likelihood of derivative litigation leads to a more effective Board of Directors. To measure board effectiveness, I examine board decisions on CEO compensation and CEO replacement. Designing CEO compensation schemes is one of the major functions of the Board of Directors. Effective boards are expected to link CEO pay to firm performance, and prior literature shows that pay-for-performance schemes are an important means to align CEO incentives with shareholder interests (e.g., Jensen and Murphy, 1990; Bizjak, Brickley, and Coles, 1993). Since the 1990s, the compensation of top executives has been criticized for being excessive and decoupled from firm performance. Bebchuk and Fried (2004) show that CEOs have considerable influence over the Board of Directors, which enables them to obtain favorable pay arrangements.

I hypothesize that the threat of derivative litigation motivates directors to align with shareholders, which may lead the Board to resist a CEO's compensation demand and to impose pay-for-performance schemes. I expect that when Delaware's judicially-led reforms increased the likelihood of derivative litigation, Delaware corporations exhibited higher sensitivity of CEO pay to firm performance. My first hypothesis is that:

Hypothesis 1*: Higher likelihood of derivative litigation leads to higher CEO pay-for-performance sensitivity.*

In addition, I examine the quality of the Board's decisions on CEO replacement. Effective boards are expected to remove under-performing management in a timely manner. I argue that the threat of derivative litigation may motivate directors to perform the function of replacing poorly-performing CEOs, as they have more incentives to develop a shareholder-friendly reputation. In the empirical literature, researchers measure the sensitivity of CEO turnover to firm performance, and use this measure to evaluate the quality of the Board's decisions. I expect that following the Delaware's judicially-led reforms, Delaware firms exhibit greater sensitivity of CEO turnover to firm performance. Formally, I test the following hypothesis:

Hypothesis 2: *Higher likelihood of derivative litigation leads to greater CEO turnover-performance sensitivity.*

3.4. Data and Model Specification

My sample consists of 2153 publicly-traded firms from 1999 -2007. I obtain data on CEO compensation from the ExecuComp database. ExecuComp contains information on the top executives of firms in the S&P 500, S&P MidCap, and S&P SmallCap indexes. CEO compensation is comprised of cash compensation (salary, bonus, and other annual cash payouts), total value of restricted stock granted, total value of stock options (calculated using the Black-Scholes method), and other long-term incentive payouts. Following Parrino (1997), CEO turnovers are classified into forced and voluntary turnovers. I focus on forced CEO turnover, which includes all departures for which the CEO is fired, forced from the position, or departs due to policy differences. The data on CEO forced turnover are provided by Jenter and Kanaan (2015).[17] To construct turnover-performance sensitivity and pay-for-performance sensitivity, I collect stock return data from the Center for Research in Security Prices (CRSP). I use firm 12-month stock returns adjusted by value-weighted industry (3-digit SIC) returns. I also measure stock return volatility, defined as the standard deviation of the previous 60-month stock returns.

[17] I thank Dirk Jenter and Fadi Kanaan for providing CEO turnover data. Jenter and Kanaan (2015) use ExecuComp database to identify the cases of CEO turnover, and then search Factiva news database to determine whether the CEO turnover is forced or voluntary, as well as the exact turnover announcement date.

CEO characteristics can affect Board of Director decisions on CEO compensation and dismissal. Allen (1981) and Lambert *et al.* (1993) show that CEO compensation is lower when the CEO has larger holdings of firm's stock. Booth, Cornett and Tehranian (2002) argue that concentrating management's power and board leadership in one person's hands can exacerbate potential conflicts of interest, decreasing the effectiveness of monitoring. I control for CEO characteristics, such as CEO ownership, CEO tenure, and whether the CEO is also chairman of the Board. Data on CEO characteristics are obtained from the ExecuComp database.

I also control for Board and corporate governance characteristics. Prior literature shows that Board size and composition affect board effectiveness. For example, Lipton and Lorsch (1992) and Yermack (1996) show that large boards are associated with poor communication and decision making, and limiting the size of the Board improves Board efficiency. Weisbach (1988) demonstrates that inside and outside directors behave differently in monitoring CEOs. Outsider-dominated boards are more likely to replace poorly-performing CEOs than insider-dominated boards. Hallock (1997) shows that CEO compensation is higher at firms with interlocked outside directors. Fich and Shivdasani (2006) find that when a majority of board members serve on three or more outside boards, the sensitivity of CEO turnover to performance is significantly lower. Adams and Ferreira (2009) show that gender-diverse boards allocate more effort to monitoring. Following these literature, I include variables such as Board size, Board independence, faction of interlocking directors, average director's outside board seats, fraction of female directors, as control variables. I also include a governance index (G-index) to proxy for the level of shareholder rights (Gompers, Ishii, and Metrick, 2003). I obtain data on Board and corporate governance characteristics from the RiskMetrics database, which contains firms in the Standard & Poor's 1500 index. I follow Coles, Daniel, and Naveen (2014) to address the data problems with RiskMetrics.

Following prior literature, I also include firm characteristics as control variables, such as firm assets, Tobin's Q, institutional ownership, stock return volatility, capital expenditure, and firm age. I obtain data on these firm characteristics from the Compustat database. Detailed variable definitions are provided in Table 3.1.

In Table 3.2, I present summary statistics for the main variables used in the study. The CEO compensation variable is skewed, with median CEO pay being $2.95 million, and mean CEO pay being $5.69 million. The variable of forced CEO turnover is also skewed. In my sample period, I observe 538 forced turnovers out of 16,101 firm-year observations.

Table 3.1. Variable Definition

Variables	Definition	Data Source
CEO Compensation	Item TDC1 in ExecuComp. CEO total compensation is comprised of the following: Salary, Bonus, Other Annual, Total Value of Restricted Stock Granted, Total Value of Stock Options Granted (using Black-Scholes), Long-Term Incentive Payouts, and All Other Total.	ExecuComp
CEO Turnover	An indicator variable equal to one if there is a forced CEO turnover in firm i in year t, and equal to zero if CEO turnover is voluntary or no CEO turnover occurs. The classification of CEO turnovers into forced and voluntary is based on Parrino (1997).	Jenter and Kanaan (2015)
Industry-adjusted Stock Return	A firm's stock return adjusted by the value-weighted industry (3-digit SIC) returns, compounded over 12 months. In CEO turnover regressions, the 12-month period ends one month before the CEO turnover announcement, or ends at the end of calendar year if there is no CEO turnover. In CEO compensation regressions, the 12-month period ends at the end of the calendar year.	Center for Research in Security Prices (CRSP)
CEO Ownership	The percentage of a firm's outstanding shares owned by CEO.	ExecuComp
CEO Tenure	The number of years that a CEO holds his/her position.	ExecuComp
CEO Chairman	An indicator variable equal to one if a firm's CEO is also the chairman of the board, and equal to zero otherwise.	ExecuComp
Board Size	The total number of directors on a firm's board.	RiskMetrics
Fraction Independent Directors	The number of independent directors divided by the total number of directors.	RiskMetrics
Classified Board	An indicator variable equal to one if a firm's board is classified board, and zero otherwise. Classified board (also known as staggered board) refers to the board of directors that is divided into separate classes for the purpose of election. In most instances, there are three classes, with only one class of directors stand for election in any one year.	RiskMetrics
Average Director Tenure	The number of years that a director serves on a firm's board, averaged across all directors in a firm.	RiskMetrics
Average Director's Outside Board Seats	The number of outside boards that a director serves, averaged across all directors in a firm.	RiskMetrics
Fraction Female Directors	The number of female directors divided by the total number of directors.	RiskMetrics
Fraction Interlocking Directors	The number of interlocking directors (a director is interlocked if an inside officer of the firm serves on the board of that outside director's company), divided by the total number of directors.	RiskMetrics
Fraction Former Employee Directors	The number of directors who are former employees of the firm, divided by the total number of directors.	RiskMetrics
G Index	Governance index as defined in Gompers, Ishii, and Metrick (2003)	RiskMetrics
Dual Class Share Structure	An indicator variable equal to one if a firm's common stock has two or more classes, and zero otherwise. Dual class share structure typically grants super voting rights to one class of the stock.	RiskMetrics
Firm Assets	Firm i's book value of total assets (item # 6)	Compustat
Stock Return Volatility	The standard deviation of monthly stock returns in the past 60 months. In CEO turnover regressions, the 60-month period ends one month before the CEO turnover announcement, or ends at the end of calendar year if there is no CEO turnover. In CEO compensation regressions, the 60-month period ends at the end of the calendar year.	Center for Research in Security Prices (CRSP)
Tobin's Q	Firm i's Tobin's Q is computed as [market value of equity (item # 199×iterm # 25) + book value of assets (item # 6) − book value of equity (item #60) −balance sheet deferred taxes (item #74)] /book value of assets (item # 6)	Compustat
CapExp / Assets	Capital expenditure (item # 128) divided by lagged asset (item # 6)	Compustat
Institutional Ownership	The percentage of firm i's outstanding shares held by institutional investors.	Thomson Reuters Institutional (13f) Holdings
Firm Age	Firm i's age in year t, approximated by the number of years listed on Compustat.	Compustat

Table 3.2
Summary Statistics

Variables	5%	25%	Median	75%	95%	Mean	SD	N
CEO Compensation (in Thousands)	516	1410	2953	6700	19169	5693	11602	12293
CEO Turnover	0	0	0	0	0	0.036	0.186	12608
Industry-adjusted Stock Return	-0.527	-0.201	-0.022	0.181	0.773	0.040	0.502	12364
CEO Ownership	0.000	0.001	0.003	0.012	0.128	0.023	0.060	11950
CEO Tenure	0	2	5	9	22	6.890	7.241	12345
CEO Chairman	0	1	1	1	1	0.767	0.423	12364
Board Size	6	7	9	11	14	9.432	2.726	12364
Fraction Independent Directors	0.375	0.571	0.714	0.818	0.900	0.682	0.166	12364
Classified Board	0	0	1	1	1	0.601	0.490	11639
Average Director Tenure	3.111	5.778	8	10.692	16	8.926	22.317	12363
Average Director's Outside Seats	0	0.364	0.727	1.182	1.929	0.823	0.605	12364
Fraction Female Directors	0	0	0.100	0.154	0.250	0.099	0.007	12364
Fraction Interlocking Directors	0	0	0	0	0.071	0.007	0.030	12364
Fraction Former Employee Directors	0	0	0	0.100	0.200	0.049	0.078	12364
G Index	5	7	9	11	14	9.313	2.610	10315
Dual Class Share Structure	0	0	0	0	1	0.090	0.287	11639
Firm Assets (in Millions)	210	682	1892	6635	43645	14781	75226	12363
Stock Return Volatility	0.055	0.083	0.108	0.151	0.241	0.124	0.062	12361
Tobin's Q	0.852	1.179	1.604	2.529	5.811	2.364	3.635	12358
CapExp / Assets	0.002	0.020	0.040	0.072	0.181	0.059	0.067	11874
Institutional Ownership	0.347	0.570	0.718	0.840	0.920	0.724	2.439	12320
Firm Age	6	12	21	41	54	26.172	16.321	12363

I first compare the changes in CEO pay-for-performance sensitivity from a pre-event period (2000-2002) to a post-event period (2003-2005), between Delaware firms and non-Delaware firms. I specify the following model:

$$COMP_{i,t} = \beta_0 + \beta_1 \times RET_{i,t} + \beta_2 \times RET_{i,t} \times DELAWARE_i + \beta_3 \times RET_{i,t} \times POST_t + \beta_4 \times DELAWARE_i \times POST_t + \beta_5 \times RET_{i,t} \times DELAWARE_i \times POST_t + \gamma X_{i,t} + \nu_i + \mu_t + \varepsilon_{i,t} \quad (15)$$

Here, $COMP_{i,t}$ represents the CEO's compensation at firm i in year t. I use natural logarithmic transformation of $COMP_{i,t}$. $RET_{i,t}$ is firm i's industry-adjusted stock return in year t. $DELAWARE_i$ is an indicator variable that equals one if firm i is incorporated in Delaware. $POST_t$ is an indicator variable which takes the value one if the observation occurs in the post-event period (2003-2005), and zero otherwise. X_{it} is a vector of firm-level controls, including CEO characteristics, Board and governance characteristics, and firm characteristics. I include firm fixed effects ν_i to control for unobserved heterogeneity. μ_t is year fixed effects. $\varepsilon_{i,t}$ is an i.i.d. error term. The specification does not include the non-interacted $DELAWARE_i$ and $POST_t$, because they are subsumed in the firm and year fixed effects. In (1), β_1 is the estimate of the sensitivity of CEO compensation to changes in returns. The coefficient of main interest is β_5, which measures the change in CEO pay-for-performance sensitivity that can be attributed to Delaware's judicially-led reforms in 2003. I estimate empirical model (1) using the OLS estimator.

Similarly, to test whether the directors of Delaware corporations make more timely CEO replacement decisions when firm stock price declines, I estimate the following model:

$$\begin{aligned} Prob\,(TURNOVER_{i,t}) &= \beta_0+\beta_1\times RET_{i,t}+\beta_2\times RET_{i,t}\times DELAWARE_i+\beta_3\times RET_{i,t}\times POST_t \\ &+\beta_4\times DELAWARE_i\times POST_t+\beta_5\times RET_{i,t}\times DELAWARE_i\times POST_t+\gamma X_{i,t}+\nu_i+\mu_t+\varepsilon_{i,t} \end{aligned} \tag{16}$$

Here, $TURNOVER_{i,t+1}$ is an indicator variable which takes the value one if there is a forced CEO turnover at firm i in year t, and zero otherwise. The coefficient of interest is β_5, which is a DiD estimate of the effect of the Delaware's 2003 jurisprudential shift on the sensitivity of CEO turnover to firm stock performance. Empirical model (2) is estimated using the Linear Probability Model (LPM).

3.5. Empirical Results

3.5.1. Baseline Model

The estimation results are reported in Table 3.3. Column (1) shows the effect of Delaware's judicially-led reforms on the sensitivity of CEO compensation to firm performance. The OLS regression excludes the firm-year observations in which a firm experiences CEO turnover. The reason is that ExecuComp reports the compensation of either new CEO or replaced CEO in the turnover year, in which case the compensation data are not what the CEO normally receives in the years with no turnover. For most firms, the CEO total compensation reported in ExecuComp is lower in CEO turnover years than in other years. The coefficient on the interaction term *Stock Return* × *Delaware* × *Post* in column (1) is positive and statistically significant (0.317). This suggests that following the Delaware's reforms, CEO pay-for-performance sensitivity increased significantly. When a firm's annual industry-adjusted stock returns improve (decline) by one unit, Delaware firms increase (decrease) CEO annual compensation by 31.7% more than non-Delaware firms do. In column (2), I report the estimated effects on forced CEO turnover. I find that the Delaware's judicially-led reforms lead to greater sensitivity of CEO turnover in response to change in a firm's stock performance. The probability of replacing a CEO when firm stock performance declines is significantly higher in Delaware firms than in non-Delaware firms. This effect is indicated by the negative and statistically significant coefficient on the interaction term *Stock Return*

Table 3.3: The Effects of Delaware's Judicially-led Reforms in 2003 on Board Effectiveness

Variables	CEO Compensation OLS Model (1)	CEO Turnover LPM Model (2)
Stock Return	0.077**[a]	-0.022***
	(0.032)[b]	(0.008)
Stock Return × Delaware × Post	**0.317*** **	**-0.077*** **
	(0.091)	(0.029)
Stock Return × Delaware	-0.106**	-0.001
	(0.042)	(0.011)
Stock Return × Post	-0.215***	0.010
	(0.070)	(0.023)
Delaware × Post	0.032	0.014
	(0.037)	(0.010)
CEO Ownership	-1.972***	-0.424***
	(0.451)	(0.124)
CEO Tenure	0.035	0.052***
	(0.022)	(0.006)
CEO Chairman	-0.016	-0.014
	(0.037)	(0.011)
Board Size	0.152	-0.012
	(0.106)	(0.031)
Fraction Independent Directors	-0.141	0.040
	(0.121)	(0.032)
Classified Board	0.180*	0.001
	(0.094)	(0.026)
Average Director Tenure	-0.056	-0.014
	(0.058)	(0.019)
Average Director's Outside Board Seats	0.007	0.011
	(0.037)	(0.010)
Fraction Female Directors	0.282	0.023
	(0.228)	(0.072)
Fraction Interlocking Directors	0.203	-0.062
	(0.453)	(0.135)
Fraction Former Employee Directors	-0.507**	0.215***
	(0.226)	(0.061)
G Index	0.027	-0.049
	(0.155)	(0.039)
Dual Class Share Structure	0.027	0.012
	(0.116)	(0.026)
Firm Assets	0.390***	-0.038***
	(0.046)	(0.014)
Stock Return Volatility	1.031*	0.156
	(0.579)	(0.188)
Tobin's Q	0.033***	-0.001
	(0.007)	(0.001)
CapExp / Assets	0.559**	-0.102
	(0.282)	(0.080)
Institutional Ownership	0.674***	-0.190***
	(0.156)	(0.050)
Firm Age	-0.165	0.006
	(0.189)	(0.055)
Constant	4.917***	0.382
	(1.207)	(0.351)
Year FE, Firm FE	Yes	Yes
Observations	6228	7353
Adjusted R^2	0.727	0.083

[a] ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
[b] Robust standard errors of the estimate.

× *Delaware* × *Post* (-0.077).

A key identifying assumption of DiD is the "parallel trend" assumption. In the absence of the treatment, the average change in CEO pay-for-performance sensitivity and turnover-performance sensitivity would be no different across Delaware and non-Delaware firms. To assess the validity of this key identifying assumption, I follow Bertrand and Mullainathan (2003). I investigate in greater detail the dynamic effects of Delaware's 2003 reforms on the sensitivities of CEO compensation and dismissals to firm performance. I replace the interaction term $RET_{i,t} \times DELAWARE_i \times POST_t$ in equations (1) and (2) with the interaction of $RET_{i,t} \times DELAWARE_i$ with eight time indicators. Those time variables include: *Before (-4), Before (-3)*, *Before (-2)*, and *Before (-1)* are the dummy variables that equal one if the firm-year observation is before the Delaware court decision (4 years before, 3 years before, 2 years before, and 1 year before, respectively), and zero otherwise; *After (+1)*, *After (+2)*, *After (+3)* and *After (+4)* are dummy variables equal to one if the firm-year observation is during or after the shift (1 year after, 2 years after, 3 years after, and 4 years after, respectively), and zero otherwise. In addition, $RET_{i,t} \times POST_t$ in equations (1) and (2) is replaced with interactions of $RET_{i,t}$ with the above time indicators, and $DELAWARE_i \times POST_t$ is replaced with interactions of $DELAWARE_i$ with time indicators.

As shown in Table 3.4, the estimated coefficients on the interaction terms *Stock Return × Delaware × Before (-3), Stock Return × Delaware × Before (-2) , and*

Table 3.4: Dynamic Analysis of the Effects of Delaware's 2003 Judicially-led Reforms

Treatment firms are the U. S. publicly-traded firms incorporated in Delaware. Control firms are the U. S. publicly-traded firms incorporated in other states. *Before (-4)*, *Before (-3)*, *Before (-2)*, and *Before (-1)* are the dummy variables that equal one if the firm-year observation is before Delaware's jurisprudential shift. *After (+1)*, *After (+2)*, *After (+3)* and *After (+4)* are dummy variables equal to one if the firm-year observation is during or after the shift. In all regressions, I include (1) the interaction of $RET_{i,t} \times DELAWARE_i$ with the above time indicators; (2) the interaction of $RET_{i,t}$ with the above time indicators (not reported on the table); and (3) the interaction of $DELAWARE_i$ with time indicators (not reported on the table). The omitted group (benchmark) is the observations at *Before (-4)*.

Variables	CEO Compensation OLS Model (1)	CEO Turnover LPM Model (2)
Stock Return	-0.104	-0.022
	(0.069)	(0.018)
Stock Return × Delaware × Before (-3)	-0.087	0.019
	(0.109)	(0.028)
Stock Return × Delaware × Before (-2)	-0.051	-0.039
	(0.103)	(0.026)
Stock Return × Delaware × Before (-1)	-0.156	-0.002
	(0.134)	(0.038)
Stock Return × Delaware × After (+1)	-0.107	**-0.126****
	(0.146)	(0.058)
Stock Return × Delaware × After (+2)	**0.361**** [a]	-0.064
	(0.158) [b]	(0.042)
Stock Return × Delaware × After (+3)	0.207	-0.075*
	(0.170)	(0.040)
Stock Return × Delaware × After (+4)	-0.199	-0.056
	(0.200)	(0.070)
Stock Return × Delaware	0.014	0.013
	(0.078)	(0.020)
Control Variables	Yes	Yes
Year FE, Firm FE	Yes	Yes
Observations	8298	9833
Adjusted R^2	0.716	0.067

[a] ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

[b] Robust standard errors of the estimate.

Stock Return $\times$ *Delaware* $\times$ *Before (-1)* are statistically indistinguishable from zero. These results suggest that the Delaware and non-Delaware firms have similar trends in CEO pay-for-performance sensitivity and CEO turnover-performance sensitivity prior to the Delaware court decision. The estimate in column (1) shows that the effect of Delaware's reforms on CEO pay-for-performance sensitivity appears two years after the Delaware court decision that increased shareholder litigation power. The estimate in column (2) shows that a significant change in CEO turnover-performance sensitivity occurs one year after the court decision. The reforms provide stronger immediate incentives for boards of directors to replace under-performing CEOs.

I observe that Delaware's judicially-led reforms in 2003 have a stronger effect on board monitoring effectiveness during the early period than during the later period. As discussed in previous sections, Delaware's judicially-led reforms in 2003 were a response to the preemptive threat of federal legislature. As the federal threat receded over time, Delaware courts relaxed the tough fiduciary standard that judges had imposed through earlier decisions (Jones, 2011). This explains the decline in the effect of the Delaware's reforms on director incentives to monitor CEOs. In addition, Delaware has a prominent role in the development of corporate law. Given Delaware court expertise in complex corporate litigation, other state courts often follow Delaware's lead. So, after Delaware courts imposed stricter fiduciary standards for directors and officers, the courts of the other jurisdiction

Table 3.5: Placebo Tests

Columns (1) and (3) report the difference-in-differences estimates using placebo event in 2001. Columns (2) and (4) report the difference-in-differences estimates using placebo event in 2005. All regressions include control variables as in Table 3.3.

	CEO Compensation OLS Model		CEO Turnover LPM Model	
	1999-2002 Placebo event in 2001	2003-2006 Placebo event in 2005	1999-2002 Placebo event in 2001	2003-2006 Placebo event in 2005
Variables	(1)	(2)	(3)	(4)
Stock Return	-0.077	-0.050	-0.033**	-0.025
	(0.053)	(0.064)	(0.014)	(0.026)
Stock Return × Delaware × PostPlacebo	**-0.017**	**-0.041**	**-0.020**	**-0.009**
	(0.093)	(0.133)	(0.028)	(0.051)
Stock Return × Delaware	0.002	-0.024	0.013	-0.032
	(0.059)	(0.085)	(0.016)	(0.033)
Stock Return × PostPlacebo	0.174**	0.210**	0.026	0.022
	(0.071)	(0.101)	(0.017)	(0.038)
Delaware × PostPlacebo	-0.090*	-0.023	-0.002	0.009
	(0.053)	(0.036)	(0.013)	(0.011)
Constant	5.185***	5.884***	0.967***	0.313
	(1.860)	(1.305)	(0.314)	(0.444)
Control Variables	Yes	Yes	Yes	Yes
Year FE, Industry FE, Firm FE	Yes	Yes	Yes	Yes
Observations	3982	4316	4783	5044
Adjusted R^2	0.707	0.784	0.082	0.095

[a] ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
[b] Robust standard errors of the estimate.

may follow. As a result, I observe that the effect of the Delaware's reforms on board monitoring effectiveness is most prominent in the first two years following the reforms.

I conduct placebo tests to further support my identification strategy. I shift the date of Delaware's judicially-led reforms two years backwards (i.e., starting in 2001) and forwards (i.e., starting in 2005). Then I replicate the difference-in-differences analysis for each placebo event. For the placebo event in 2001, I use data from 1999 to 2002. Similarly, for the placebo event in 2005, I utilize the data from 2003-2006. If our identification strategy is valid, I would not expect to observe significant treatment effects for these placebo events. In Table 3.5, I report the results from these placebo tests. Using the placebo event in 2001, the coefficients on the interaction term *Stock Return* $\times$ *Delaware* $\times$ *PostPlacebo* (-0.017 and -0.020) are statistically insignificant. This suggests that there is no differential change in CEO pay-for-performance sensitivity, or turnover-performance sensitivity between Delaware and non-Delaware firms prior to Delaware's 2003 reforms. Also, this result provides evidence that the "parallel trends" assumption is satisfied. In columns (2) and (4) I report the placebo tests using placebo event in 2005. The estimated coefficients on *Stock Return* $\times$ *Delaware* $\times$ *PostPlacebo* are both small and statistically insignificant. These placebo tests support our assertion that the documented differential change in CEO pay-for-performance and turnover-performance sensitivities (as in Table 3.3) are attributable to the Delaware judicial decisions in 2003, and they are not some artifact of the estimation procedure.

3.5.2. Propensity Score Matching

An alternative explanation for these effects is that firm characteristics determine the endogenous choice concerning the state of incorporation, and these firm characteristics lead to differential trends in the sensitivities of CEO compensation and turnover to firm stock returns after the Delaware reforms. To address this concern, I use propensity score matching to control for the difference in firm

Table 3.6: Propensity Score Matching and Difference-in-Differences Estimation

In column (1) of Panel A, I present parameter estimates from a probit regression of a binary variable indicating whether a firm is incorporated in Delaware on important firm characteristics. Using the estimated propensity score, I perform a nearest-neighbor match, where control firms are drawn with replacement. In column (2) of Panel A I report parameter estimates of the probit model estimated using the sample of matched treatment-control pairs. Panel B reports the difference-in-differences estimates of the effect of Delaware's judicially-led reforms in 2003 on board effectiveness using the propensity score matching sample.

Panel A: Comparison of pre-matching and post-matching samples, probit regressions

	Pre - Matching	Post - Matching
Dependent Variable	Delaware	Delaware
	(1)	(2)
CEO Ownership	0.023	-0.040
	(0.764)	(0.777)
CEO Tenure	-0.078	-0.014
	(0.050)	(0.044)
CEO Chairman	0.144	-0.012
	(0.108)	(0.097)
Board Size	-0.503** [a]	-0.120
	(0.214) [b]	(0.194)
Fraction Independent Directors	-0.312	0.259
	(0.300)	(0.267)
Classified Board	0.168*	0.076
	(0.093)	(0.083)
Average Director Tenure	-0.465***	0.049
	(0.116)	(0.098)
Average Director's Outside Board Seats	0.080	-0.039
	(0.075)	(0.065)
Fraction Female Directors	-1.144**	-0.500
	(0.477)	(0.422)
Fraction Interlocking Directors	-1.781	-0.079
	(1.365)	(1.364)
Fraction Former Employee Directors	0.694	0.713
	(0.546)	(0.484)
G Index	-0.644***	0.020
	(0.190)	(0.156)
Dual Class Share Structure	0.240*	0.104
	(0.141)	(0.119)
Firm Assets	0.145***	0.038
	(0.034)	(0.030)
Stock Return	-0.103	0.050
	(0.096)	(0.087)
Stock Return Volatility	0.915	-0.068
	(0.762)	(0.654)
Tobin's Q	0.020	0.004
	(0.030)	(0.028)
CapExp / Assets	-0.660	0.184
	(0.707)	(0.716)
Institutional Ownership	0.890***	-0.354*
	(0.242)	(0.211)
Firm Age	-0.204**	-0.065
	(0.079)	(0.069)
Constant	2.807***	0.128
	(0.723)	(0.614)
Observations	1211	1430
Pseudo R^2	0.097	0.006

[a] ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

[b] Robust standard errors of the estimate.

Table 3.6, Panel B. Difference-in Difference Estimation Using Propensity Score Matching Sample

Dependent Variable	CEO Compensation	CEO Turnover
Model	OLS	LPM
	(1)	(2)
Stock Return	0.073*** [a]	-0.043***
	(0.027) [b]	(0.009)
Stock Return × Delaware × Post	**0.336*** **	**-0.086*** **
	(0.081)	(0.027)
Stock Return × Delaware	-0.097**	0.020
	(0.040)	(0.012)
Stock Return × Post	-0.254***	0.014
	(0.050)	(0.021)
Delaware × Post	0.063*	0.022**
	(0.036)	(0.009)
CEO Ownership	-2.833***	-0.528***
	(0.558)	(0.124)
CEO Tenure	0.040*	0.053***
	(0.022)	(0.006)
CEO Chairman	-0.056	-0.020*
	(0.038)	(0.011)
Board Size	0.047	0.013
	(0.111)	(0.029)
Fraction Independent Directors	-0.227*	0.0123
	(0.118)	(0.027)
Classified Board	0.181*	0.002
	(0.094)	(0.026)
Average Director Tenure	-0.054	-0.014
	(0.059)	(0.019)
Average Director's Outside Board Seats	0.022	0.023***
	(0.036)	(0.009)
Fraction Female Directors	0.204	0.065
	(0.226)	(0.065)
Fraction Interlocking Directors	2.291***	-0.055
	(0.461)	(0.124)
Fraction Former Employee Directors	-1.235***	0.207***
	(0.227)	(0.056)
G Index	0.347**	-0.133***
	(0.162)	(0.040)
Dual Class Share Structure	0.0517	-0.002
	(0.131)	(0.015)
Firm Assets	0.336***	-0.011
	(0.046)	(0.012)
Stock Return Volatility	2.472***	0.042
	(0.565)	(0.159)
Tobin's Q	0.029***	-0.002*
	(0.007)	(0.001)
CapExp / Assets	0.560*	-0.048
	(0.316)	(0.070)
Institutional Ownership	0.669***	-0.141***
	(0.151)	(0.044)
Firm Age	0.060	0.023
	(0.189)	(0.049)
Constant	3.300**	0.286
	(1.345)	(0.287)
Year FE, Industry FE, Firm FE	Yes	Yes
Observations	6222	7419
Adjusted R^2	0.696	0.152

[a] ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
[b] Robust standard errors of the estimate.

characteristics that affects the assignment into treatment and control groups. The matching begins with a probit regression of a binary variable indicating whether a firm is incorporated in Delaware on important firm characteristics. I include firm characteristics identified by the previous literature to be the predictors of Delaware incorporation and the firm characteristics that may affect CEO compensation and dismissals. I measure these firm characteristics in 2002.

In Panel A of Table 3.6, I report the results of the probit regression. As reported in column (1), the specification captures a significant amount of variation in the firm choice to incorporate in Delaware, as indicated by a pseudo-R^2 of 0.097 and p-value below 0.001. I use the predicted probability from the probit estimation (the propensity score), to perform a nearest-neighbor match, where control firms are drawn with replacement. In column (2), I illustrate that after matching, the majority of differences in firm characteristics between treatment and control firms have been removed. The pseudo-R^2 of the probit regression using the post-matching sample is 0.006, which is significantly smaller than that of the pre-matching sample.

In Panel B of Table 3.6, I report the difference-in-differences estimation results based on the propensity score matching sample. I find that following the Delaware court decisions, treatment firms exhibit significantly higher CEO pay-for-performance sensitivity and higher CEO turnover-performance sensitivity. In column (1), the estimated treatment effect on CEO pay-for-performance sensitivity is 0.336, with statistical significance at the 1% level. Similarly, in column (2) the estimated treatment effect on CEO turnover-performance sensitivity is -0.086, which is statistically significant at the 1% level.

In an untabulated analysis, I conduct placebo tests and dynamic analysis. The test results using propensity score matching sample are similar to those of baseline results using all Delaware and non-Delaware firms. Overall, the findings provide evidence that enhancing shareholder litigation rights has an important impact on board of director governance decisions.

3.5.3. Sarbanes-Oxley Act and Board Independence

Finally, I examine possible confounding effects associated with passage of the Sarbanes-Oxley Act in 2002. A primary objective of the Sarbanes-Oxley Act in 2002 is to increase the independence of public company boards. Under the Act, the Securities and Exchange Commission (SEC) adopted rules that require companies listed on NYSE and NASDAQ to have a Board made up of a majority of independent directors. Prior literature shows that Board independence is an important factor affecting Board effectiveness. It is possible that following the Sarbanes-Oxley Act, Delaware firms and non-Delaware firms changed differentially in Board independence. If this is true, the documented effects of Delaware's judicially-led reforms in 2003 on board monitoring effectiveness might be driven by a change in Board independence. I test whether there is a significant change in Board independence between Delaware and non-Delaware firms following the

Table 3.7: Test for the Confounding Effect of Sarbanes-Oxley Act

In column (1) I report the result of using the baseline sample, and in column (2) I report the result for the propensity score matching sample.

Variables	Baseline Sample (All firms) *Fraction Independent Directors* OLS Model (1)	Propensity Score Matching Sample *Fraction Independent Directors* OLS Model (2)
Delaware	-0.015***[a]	-0.000
	(0.005)[b]	(0.004)
Post	0.036***	0.039***
	(0.005)	(0.004)
Delaware × Post	**0.007**	**0.001**
	(0.006)	(0.006)
Constant	0.659***	0.619***
	(0.027)	(0.027)
Control Variables	Yes	Yes
Observations	7082	7182
Adjusted R^2	0.400	0.404

[a] ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
[b] Robust standard errors of the estimate.

reforms in Delaware. I conduct a difference-in-differences test using board independence as the dependent variable.

In Table 3.7, I present the estimation results. In column (1) I report the result for the baseline sample, where all Delaware and non-Delaware firms are included. In column (2), I report the result for the propensity score matching sample. For both samples, the coefficients on the term *Post* are positive and statistically significant, indicating that both Delaware and non-Delaware firms improved board independence in response to the Sarbanes-Oxley Act. Importantly, the coefficients on the interaction term *Delaware*×*Post* are statistically indistinguishable from zero. This implies that Board independence changed in a similar pattern for Delaware and non-Delaware firms. Overall, the test shows that the Sarbanes-Oxley Act was unlikely to drive the results reported in my analysis, and it supports my view that Delaware's judicially-led reforms led to an improvement in Board effectiveness.

3.6. Conclusion

Economics and finance scholars examine how shareholders exert influence or control over corporate governance. Corporate law in the United States grants shareholders litigation rights. An important question is how shareholder litigation rights affect corporate governance. In this study, I examine Delaware's judicially-led reforms in 2003, which I argue empowered shareholders to pursue derivative litigation.

I find that following the reforms, there is evidence that boards of directors have more incentives to perform their monitoring function, and they make more effective corporate governance decisions. I document that CEO compensation and CEO turnovers in Delaware firms become more sensitive to stock return performance. Overall, these results show that empowering shareholders to pursue derivative litigation and enforcing officer and director fiduciary duties can have economically important impacts on corporate governance.

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